The Engineer

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5 MAJOR PLATE MILLS

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of five of the major 4-high plate mills in Europe. In addition, Timken bearings are extensively used on the work rolls of these and other 4-high plate mills. The illustrations show typical back-up roll applications.

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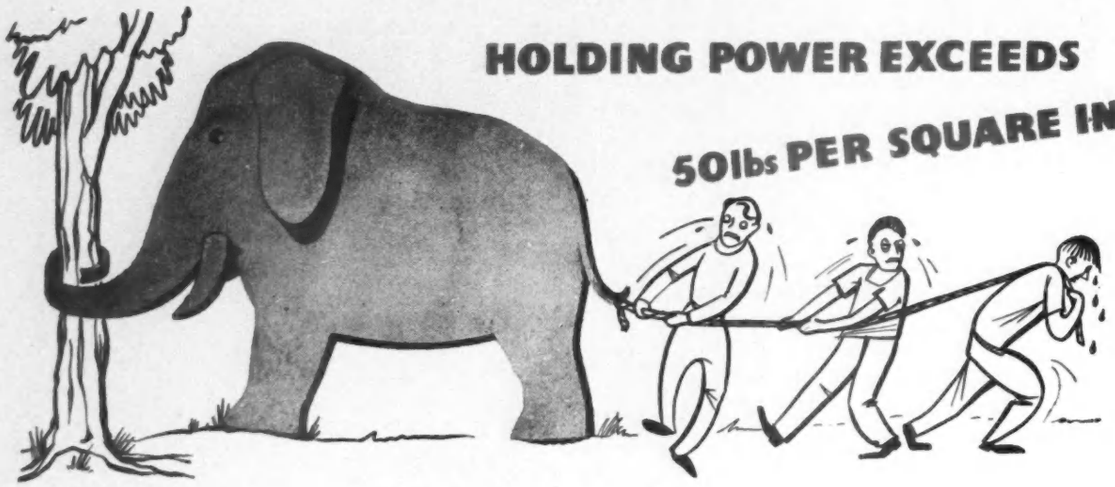

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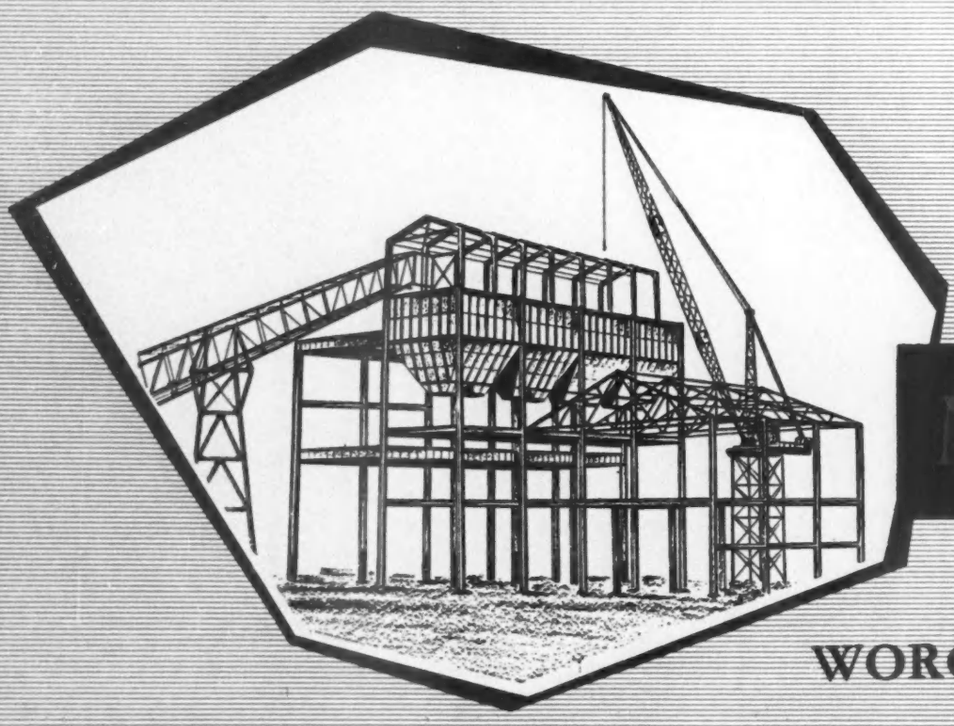

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WORCESTER

THE ENGINEER

Established 1856

No. 5352 **AUGUST 22, 1958** VOL. 206

EDITORIAL CONTENTS

Leading Articles	The T.U.C. Wonderland	281
	Power to Bargain	282
	Hydraulics Research	282
	Lunar Probes	283
	Inventiveness	283
Articles		
	100 Years Ago	283
Edward H. Livesay	French Locomotive Experiences. No. IV	284
Johnson, et al.	Creep Under Changing Complex Stress Systems. No. III	287
	Visual Landing Aid	291
T. R. Cave-Browne-Cave	Experiments with a Vortex Furnace	292
G. W. Tripp	Another Car Ferry—M.V. "Compiegne"	293
	Railbuses for British Railways	294
Fletcher & Bamborough	Development of a 75 h.p. Dynamometer Equipment	298
	Copy Grinding with Abrasive Belts	301
	Metal Spraying Pistol	302
	Oil Hardening Plant at Purfleet	304
	Radar for Port of London	305
	Belt Conveyor as a Controller	305
	Forth Road Bridge	305
	Diesel Shunting Locomotive	306
	Jet Transport Projects	306
	Self-Sealing Swivel Joint for Pipes	306
	"Diagrid" Floor for U.S. Embassy	307
	Aluminium Hatch Covers	307
	Light Television Camera	307
	Reorganisation of Steam Services	308
	Boring and Facing Head	309
	A.W.R.E. Research Reactors	309
	Power Plant for Canadian Aluminium Smelter	310
	Shaft Insulation for Traction Motor Reverser Switches	310
Continental Section		
	French Railways Electronics Exhibition	312
American Section		
	Ultrasonic Progress	315
	Shipyard Optical Marking Installation	317
	Construction of Navajo Dam in New Mexico	317
LETTERS	"The Spirit of Engineering"	296
	Æsthetics and Engineering Design	296
BOOK REVIEWS		296
OBITUARY	John Lamb, O.B.E. . . A. W. Davies	297
NEWS AND NOTES	Industrial and Labour Notes	311
	Personal and Business	318
	British Patent Specifications	319
	Technical Reports	320
	Launches and Trial Trips	320
	Catalogues and Brochures	320
	Advanced Engineering Courses	320

INDEX TO ADVERTISERS : PAGE 111 **CLASSIFIED ADVERTISEMENTS : PAGE 103**

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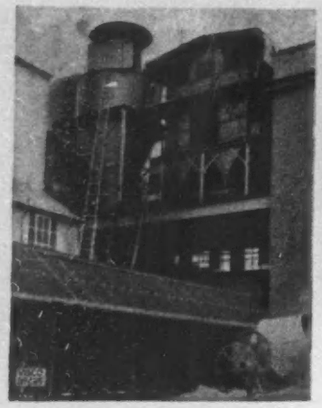
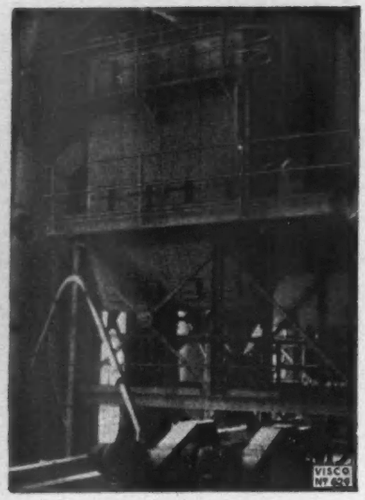


"Visco-Beth" and cyclone in course of erection at a boot and shoe factory.



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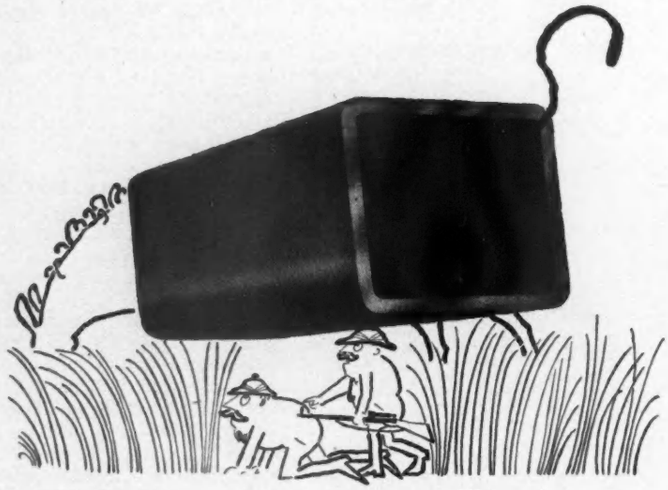

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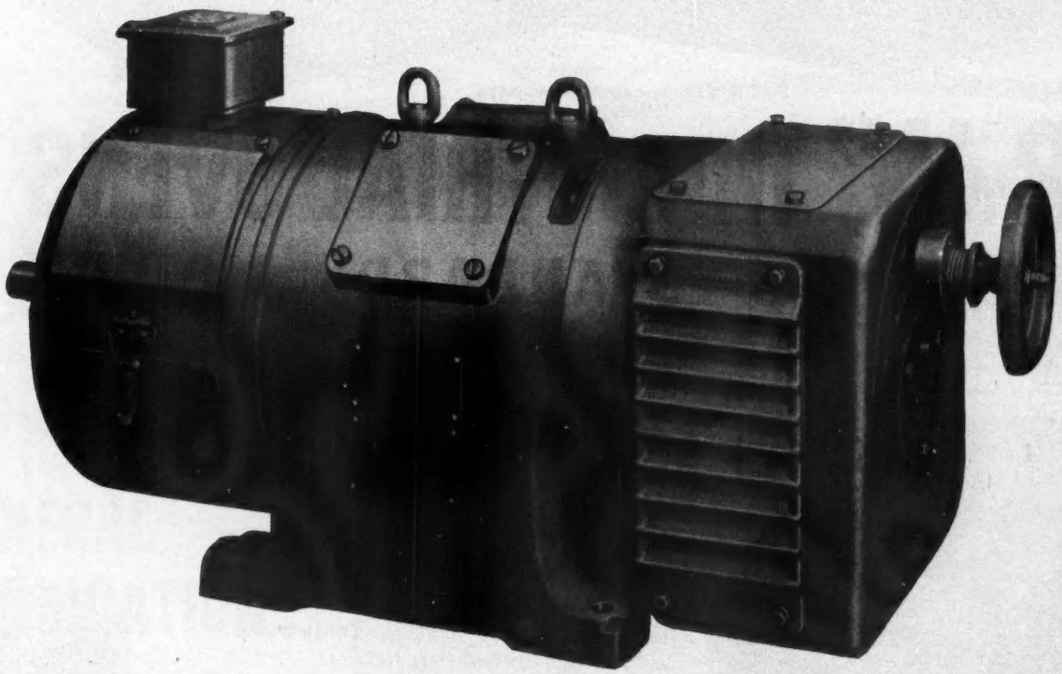

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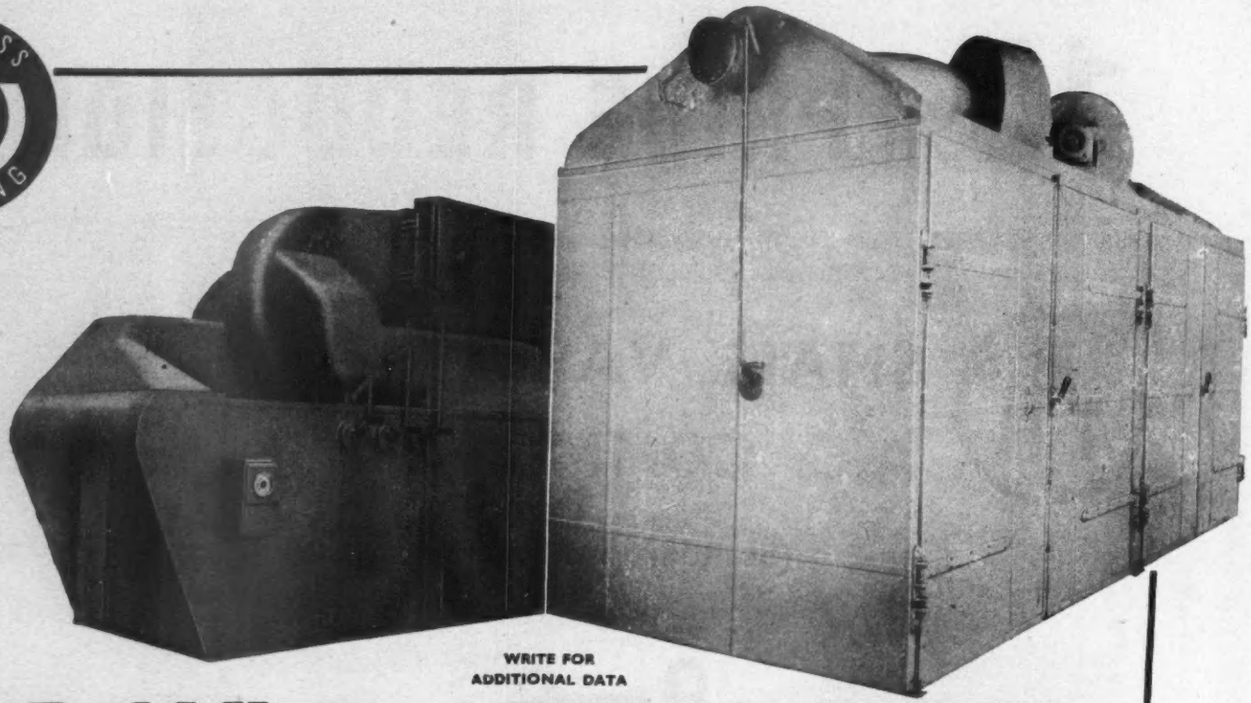

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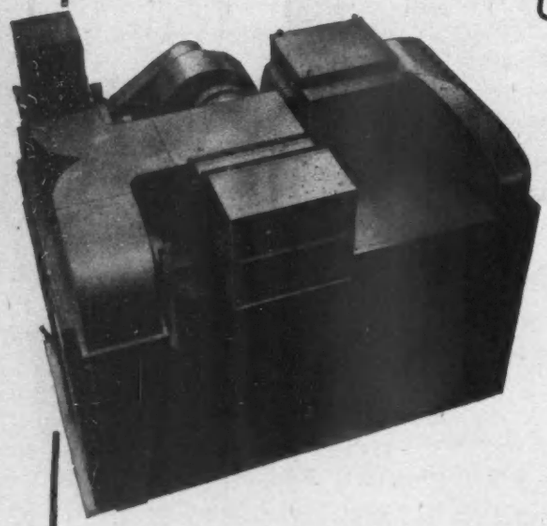

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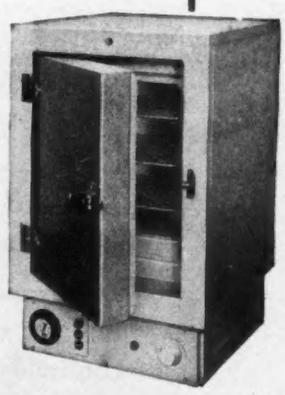

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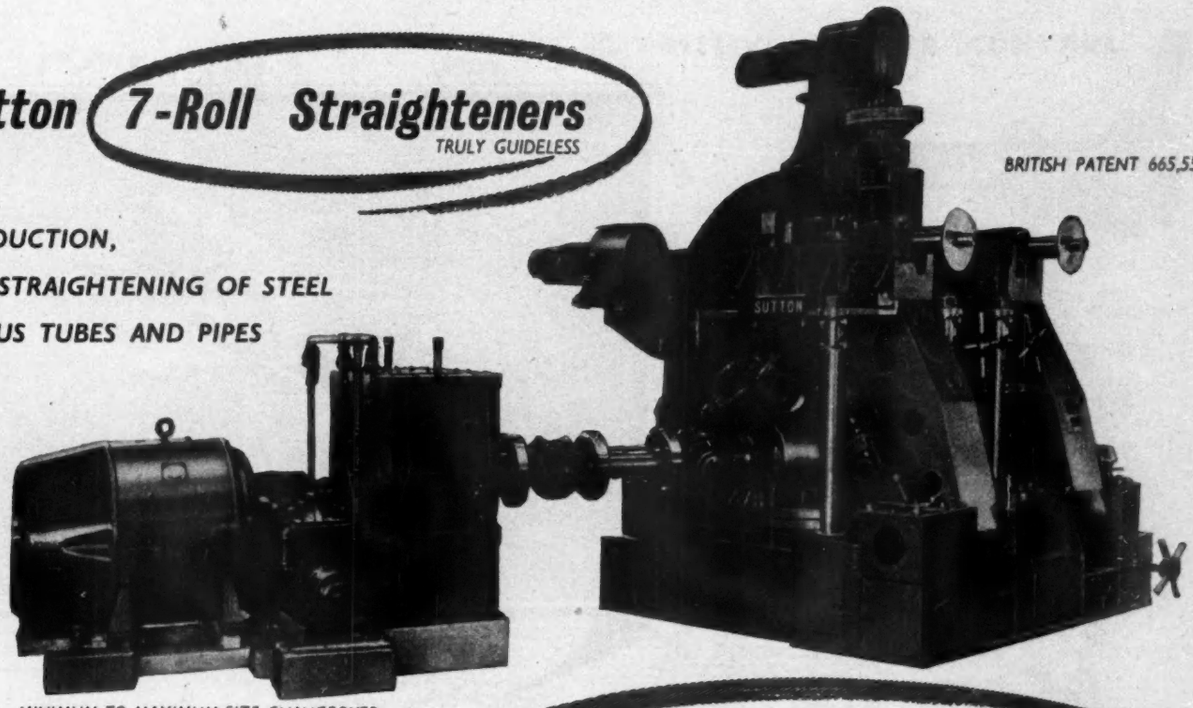

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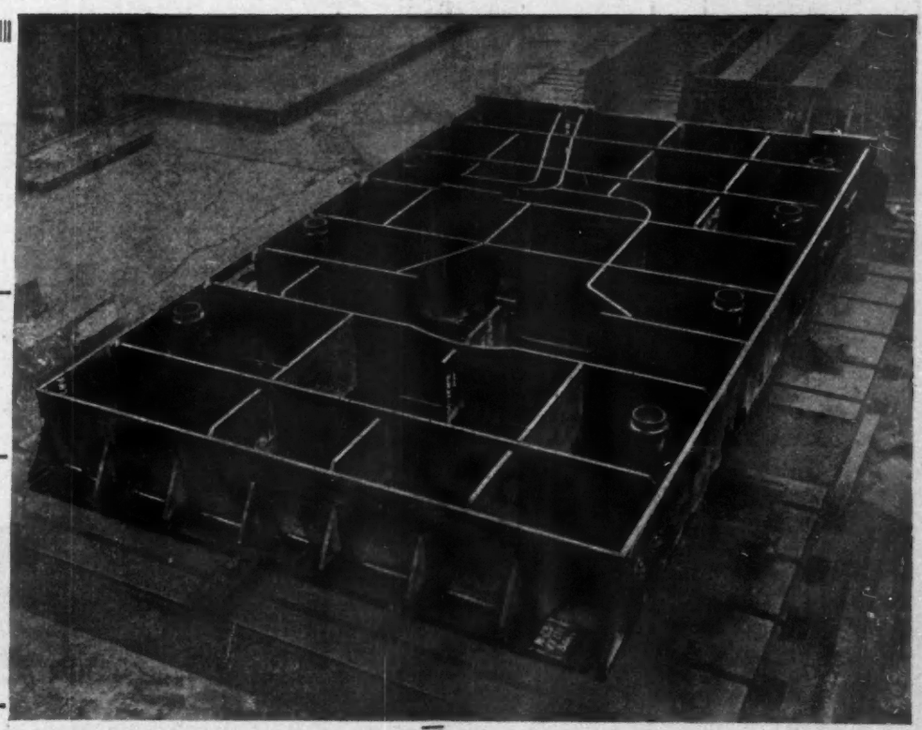

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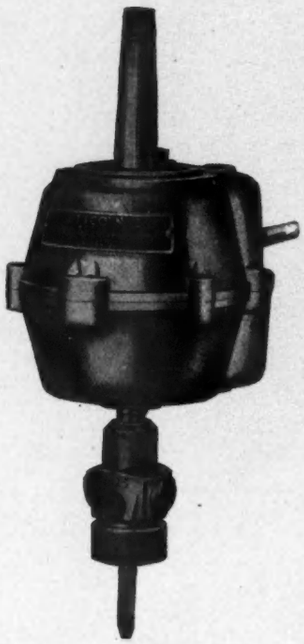

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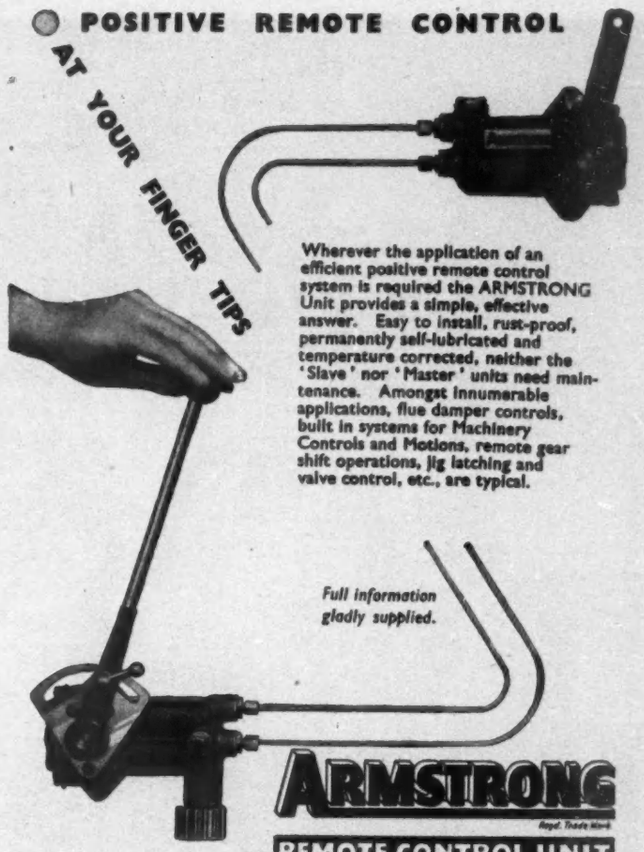

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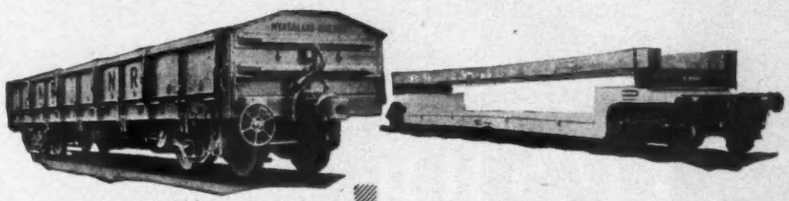

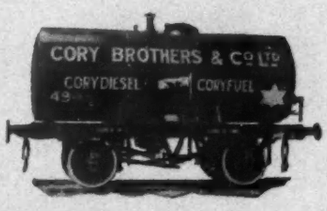

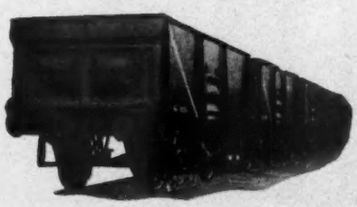

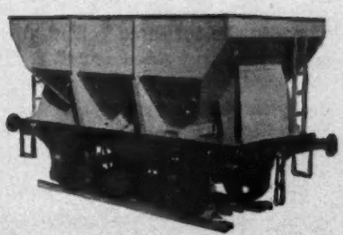

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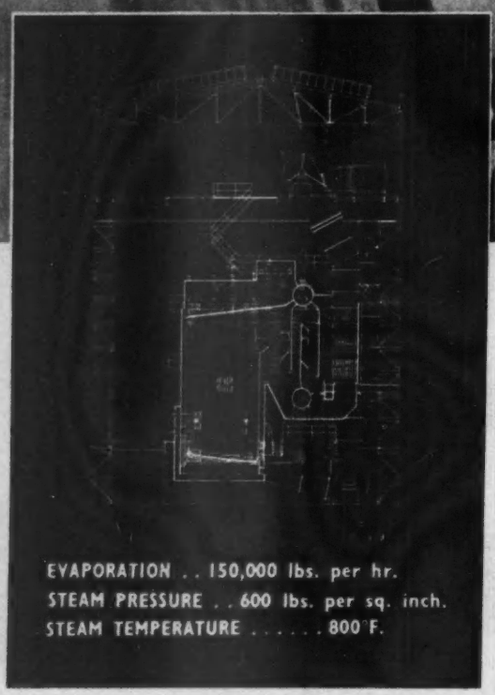

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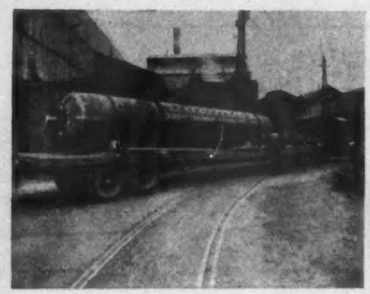

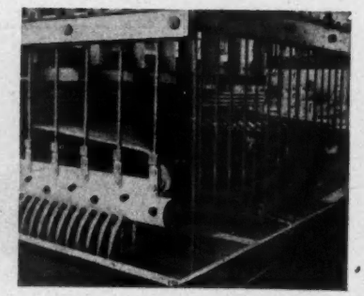

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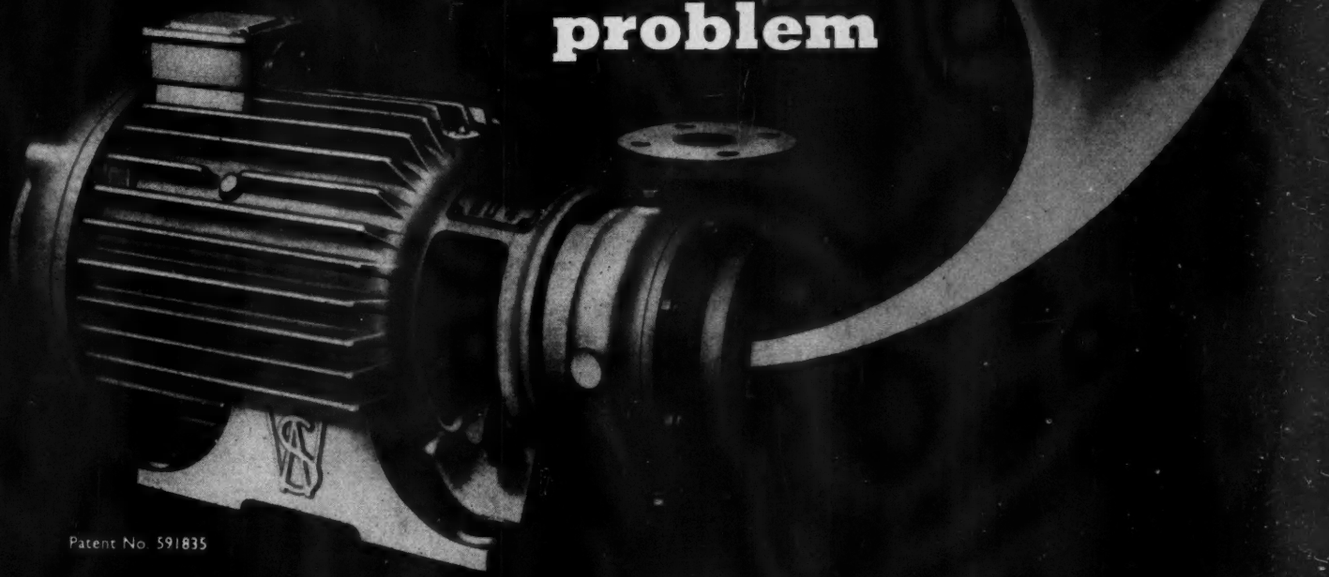

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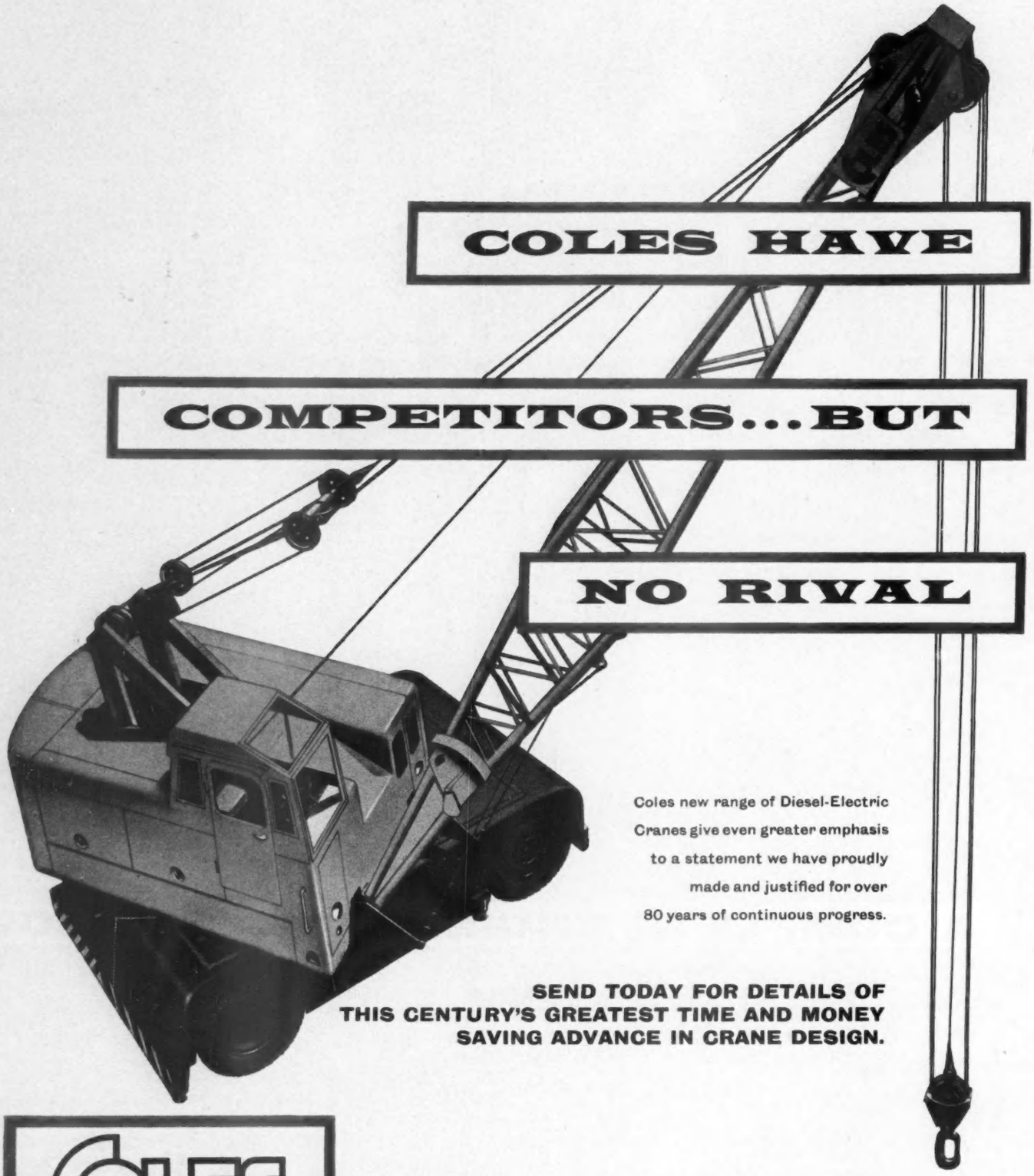

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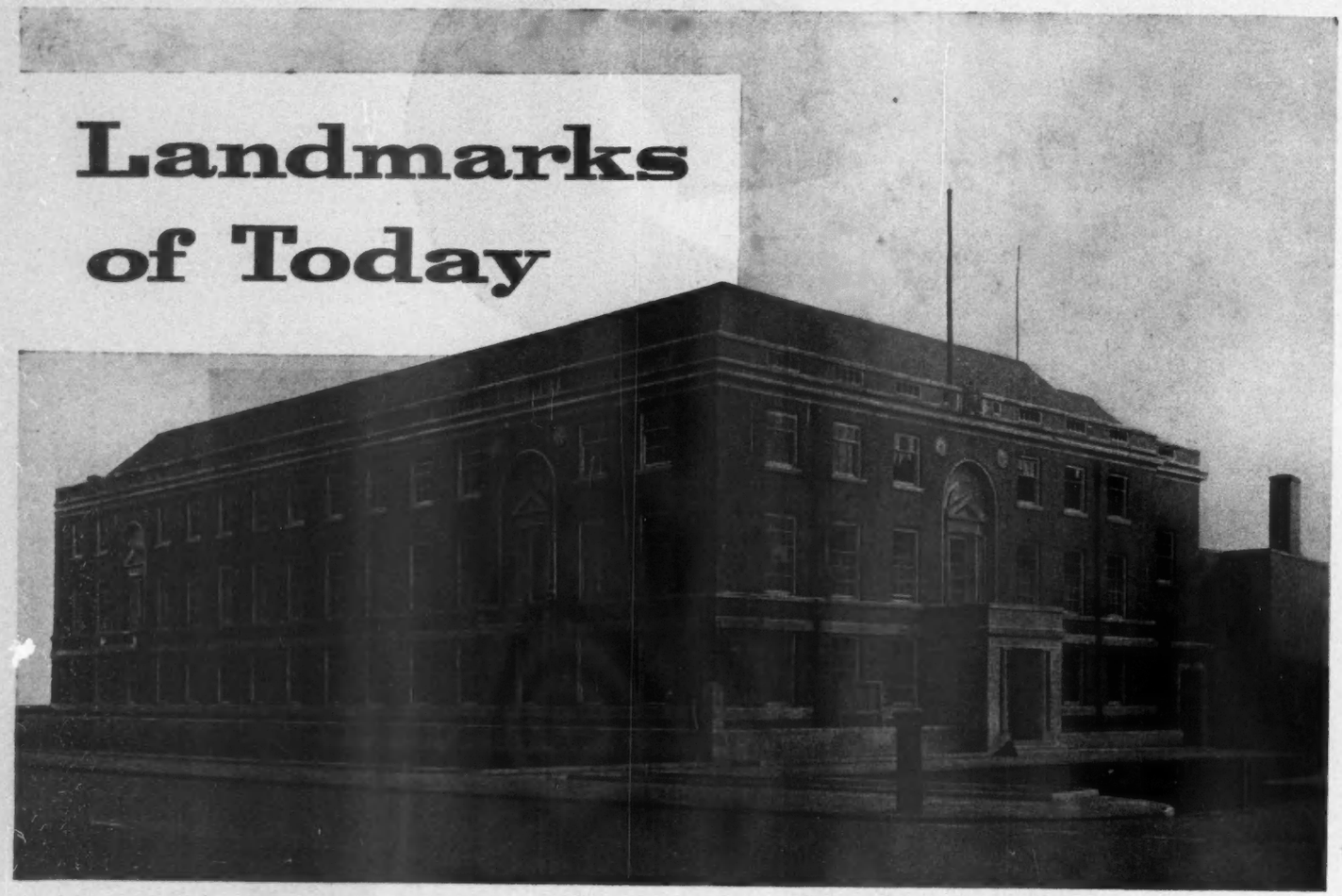

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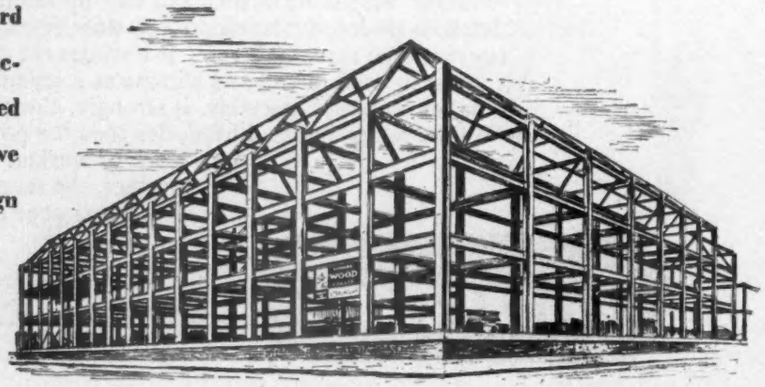

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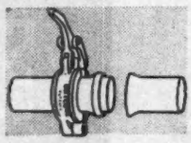
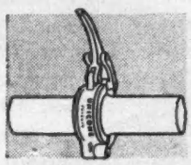

Rubber gasket in position and joint ready to pull over.


Pipe ends joined ready for locking.

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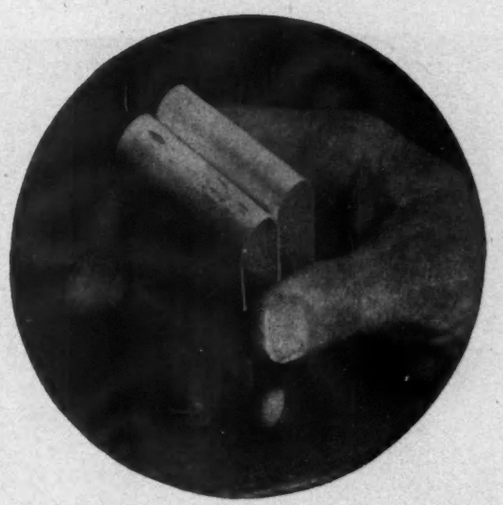

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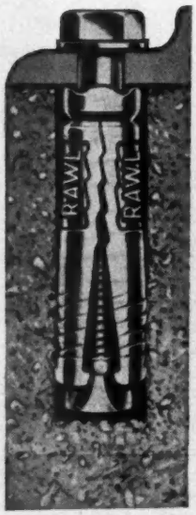

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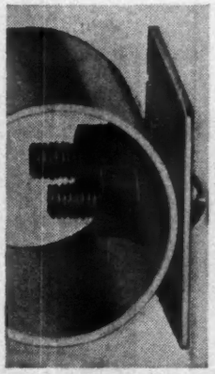

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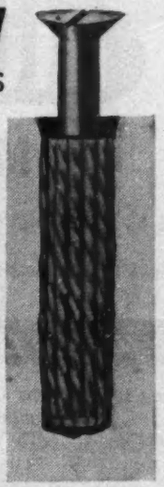

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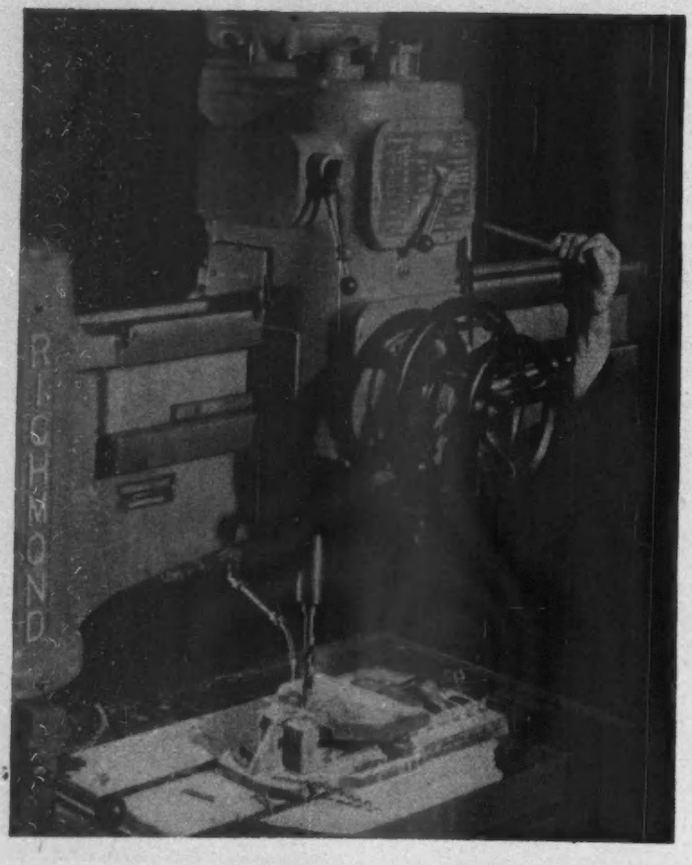

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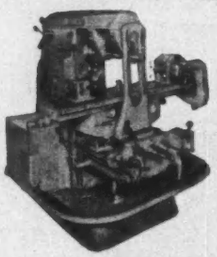

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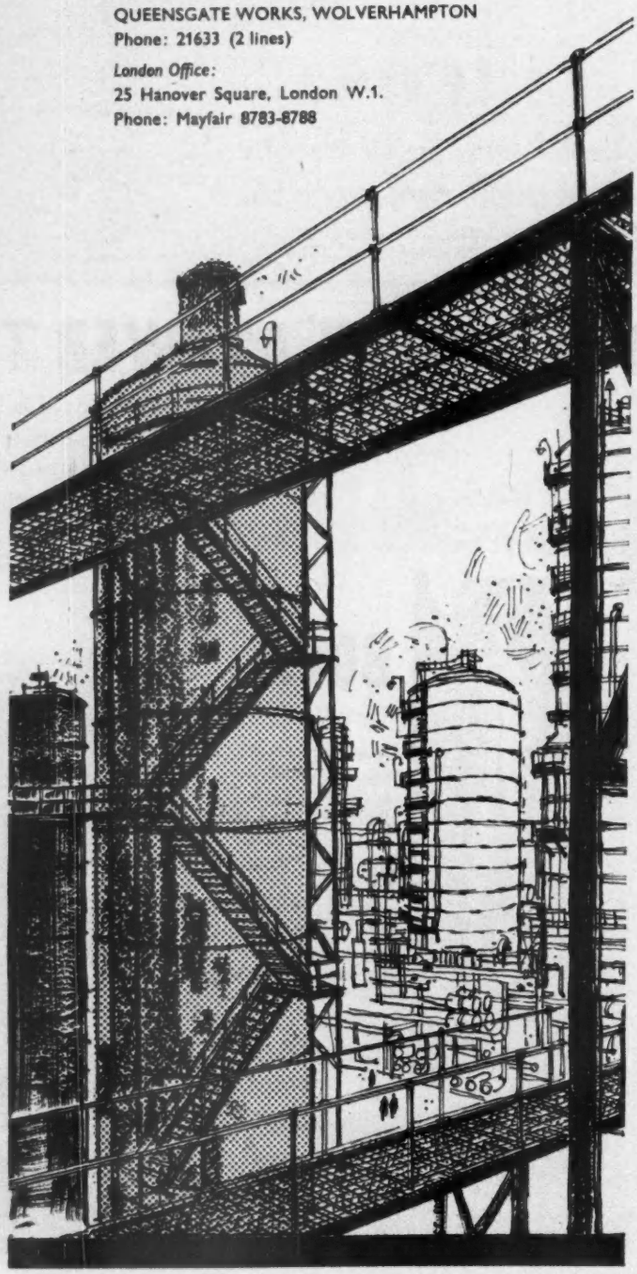

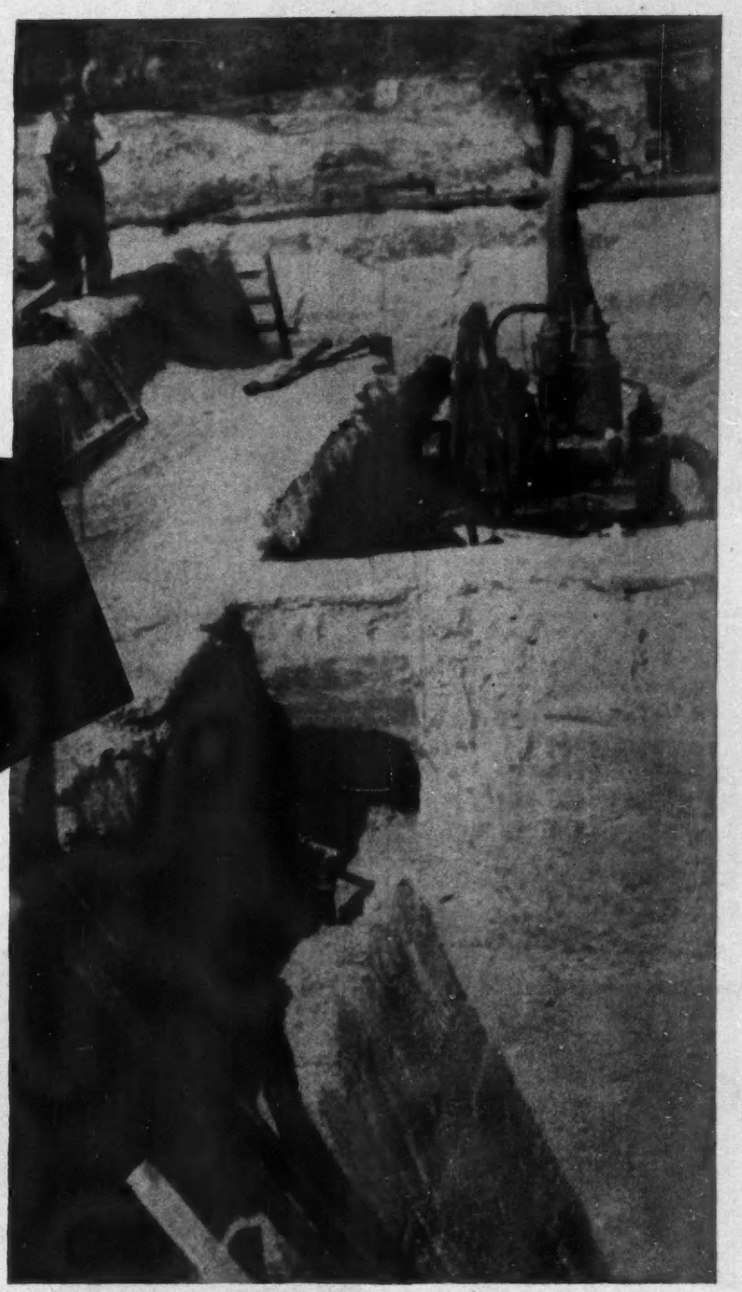

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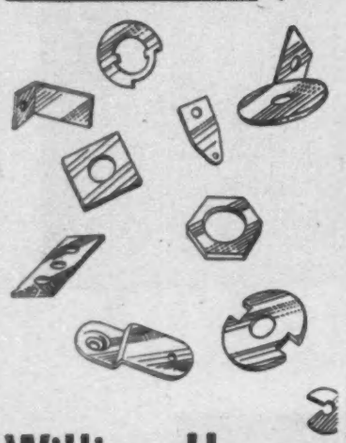

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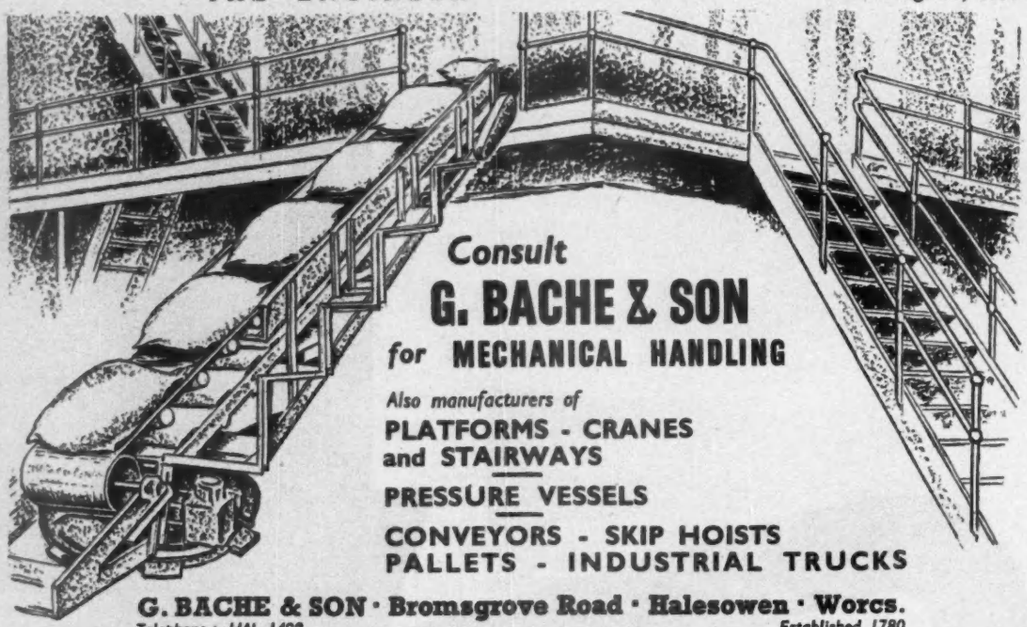

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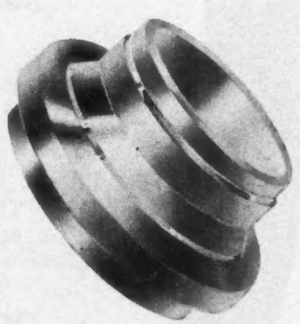

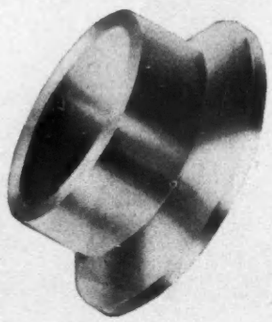

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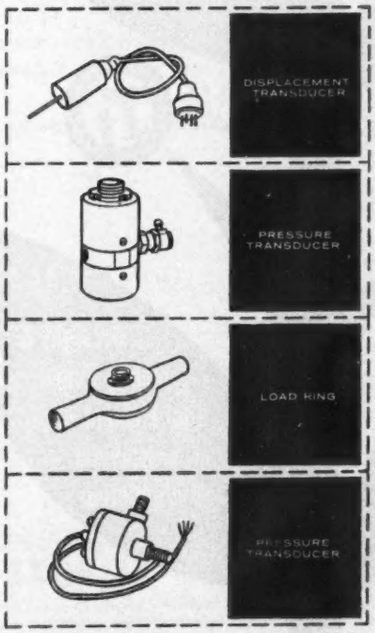

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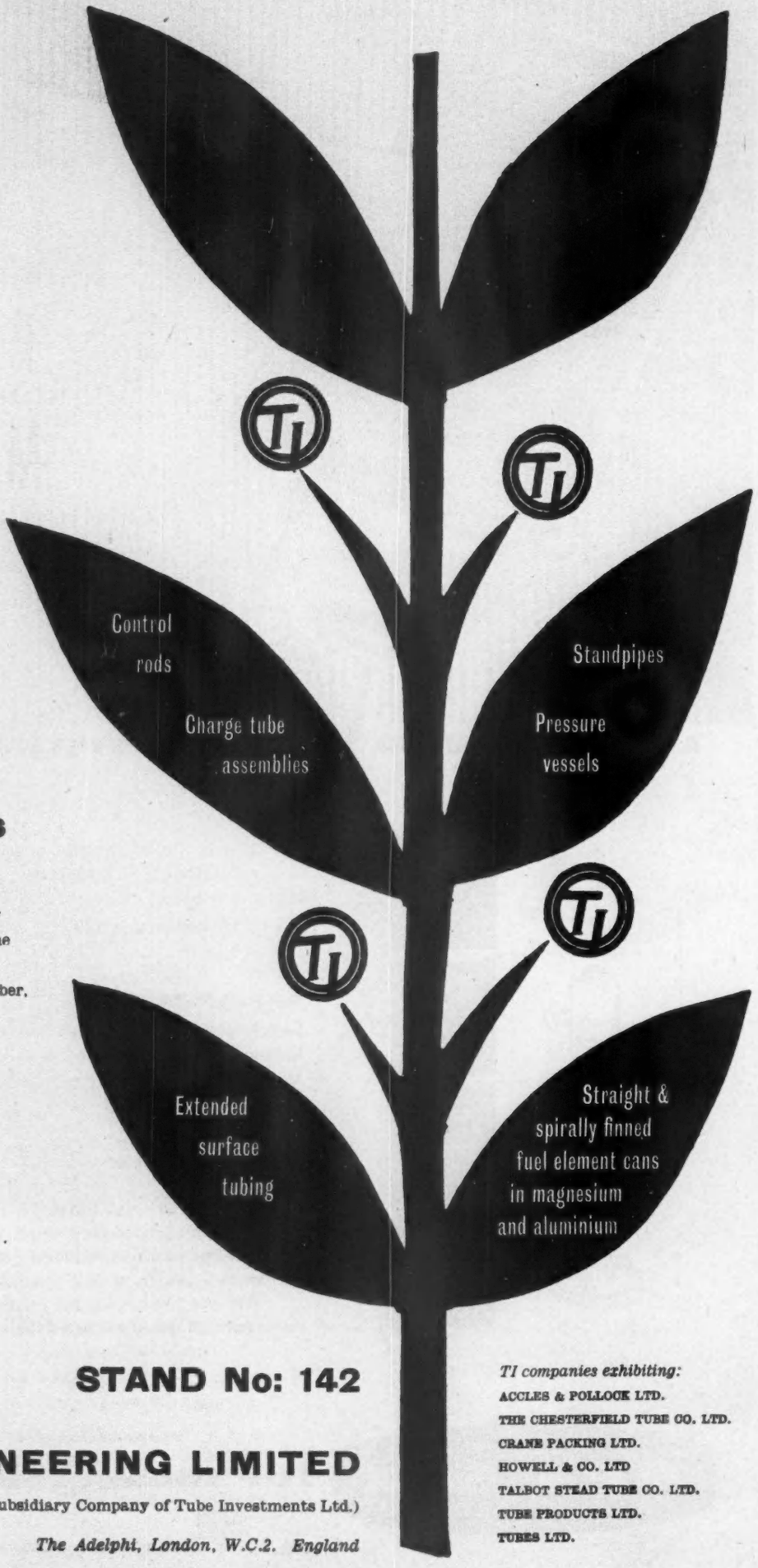

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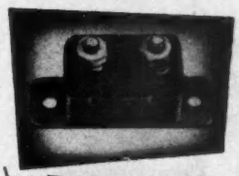

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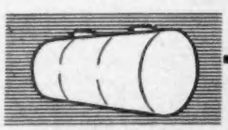

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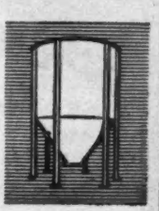

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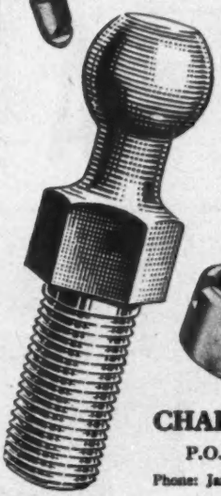

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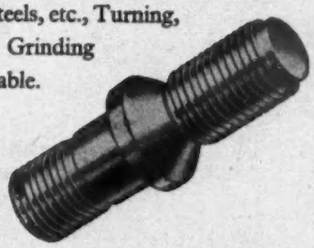

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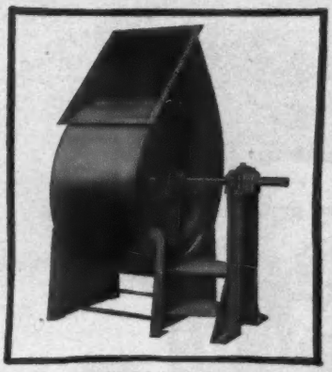

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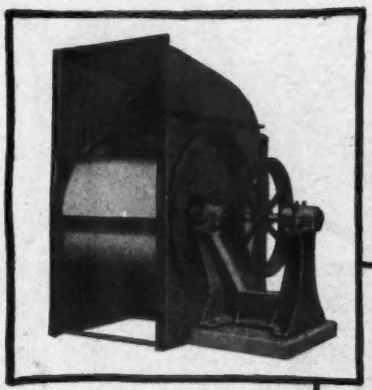

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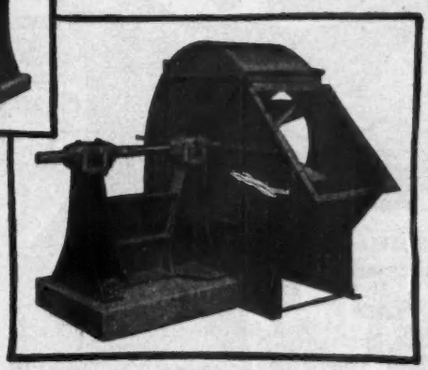

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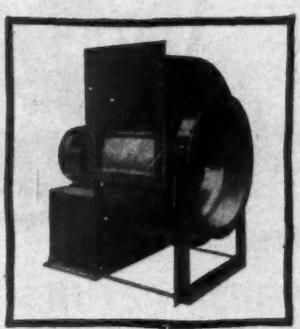

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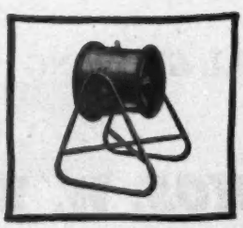

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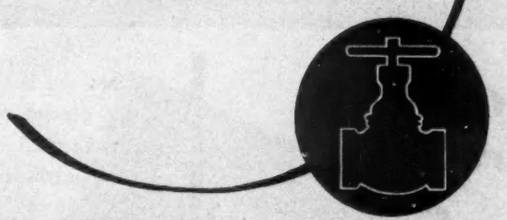

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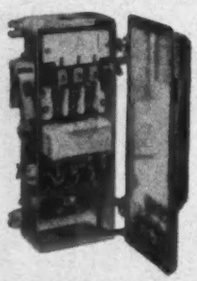
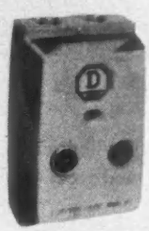


A.C. DIRECT-ON-LINE CONTACTOR with load breaking interlocked isolating switch. Up to 30 h.p.



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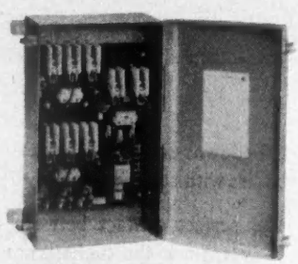

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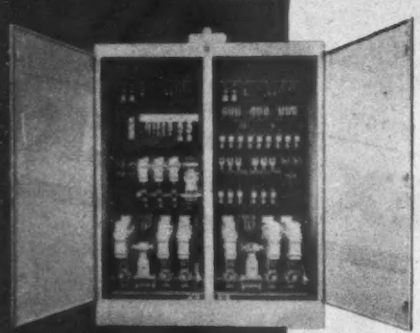

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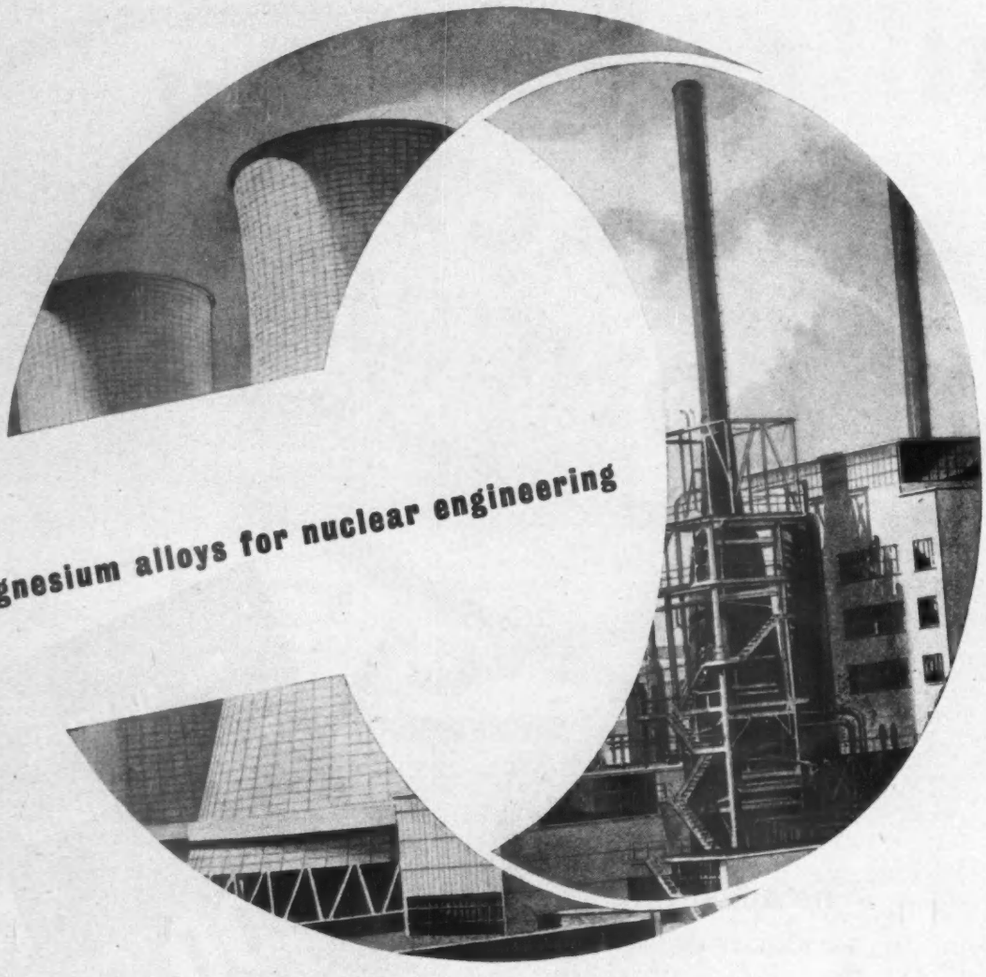

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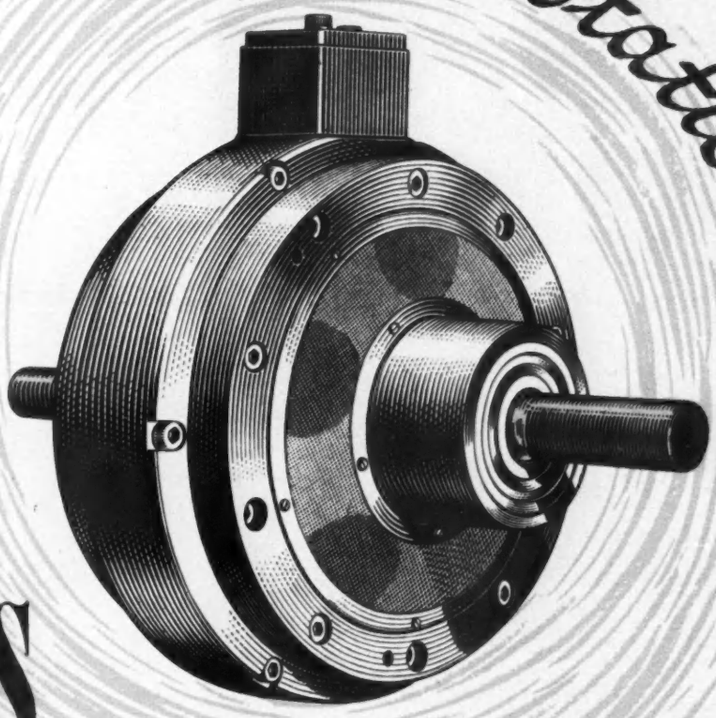

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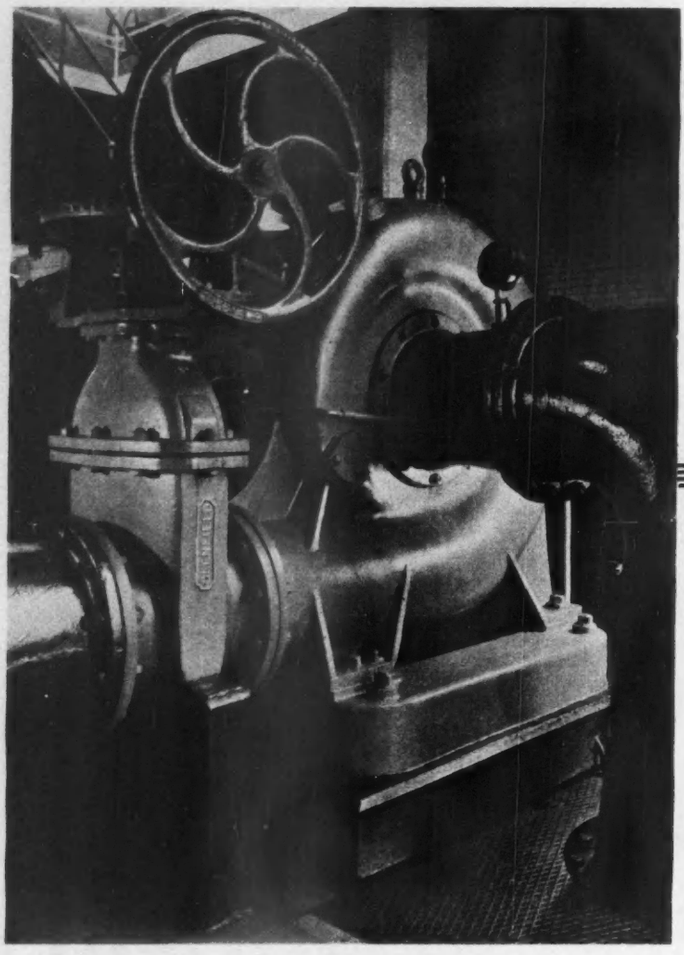

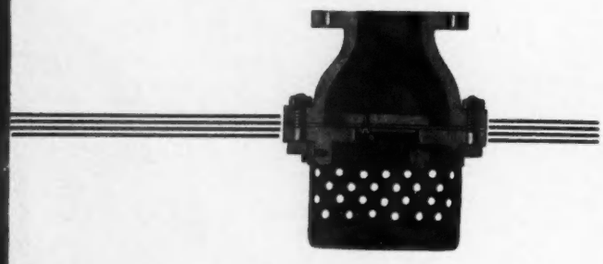

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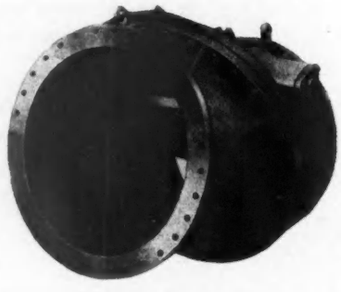

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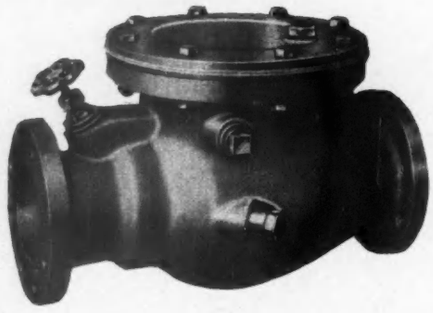

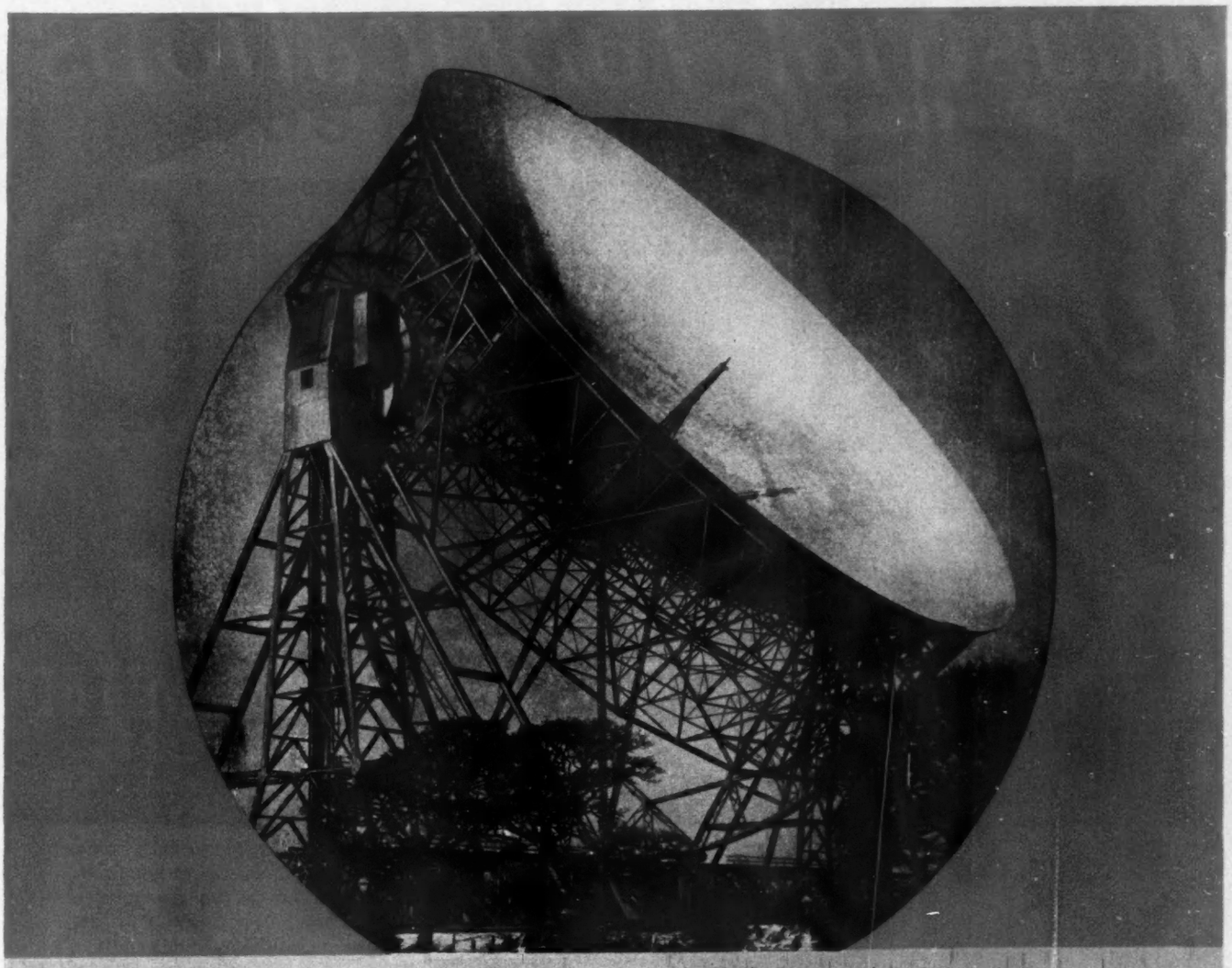

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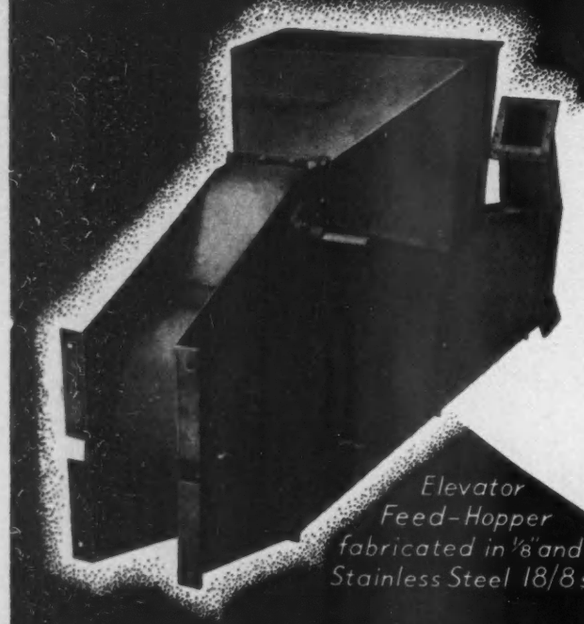

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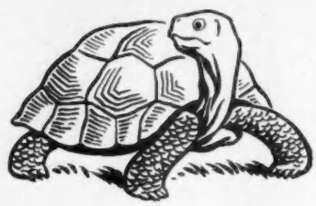

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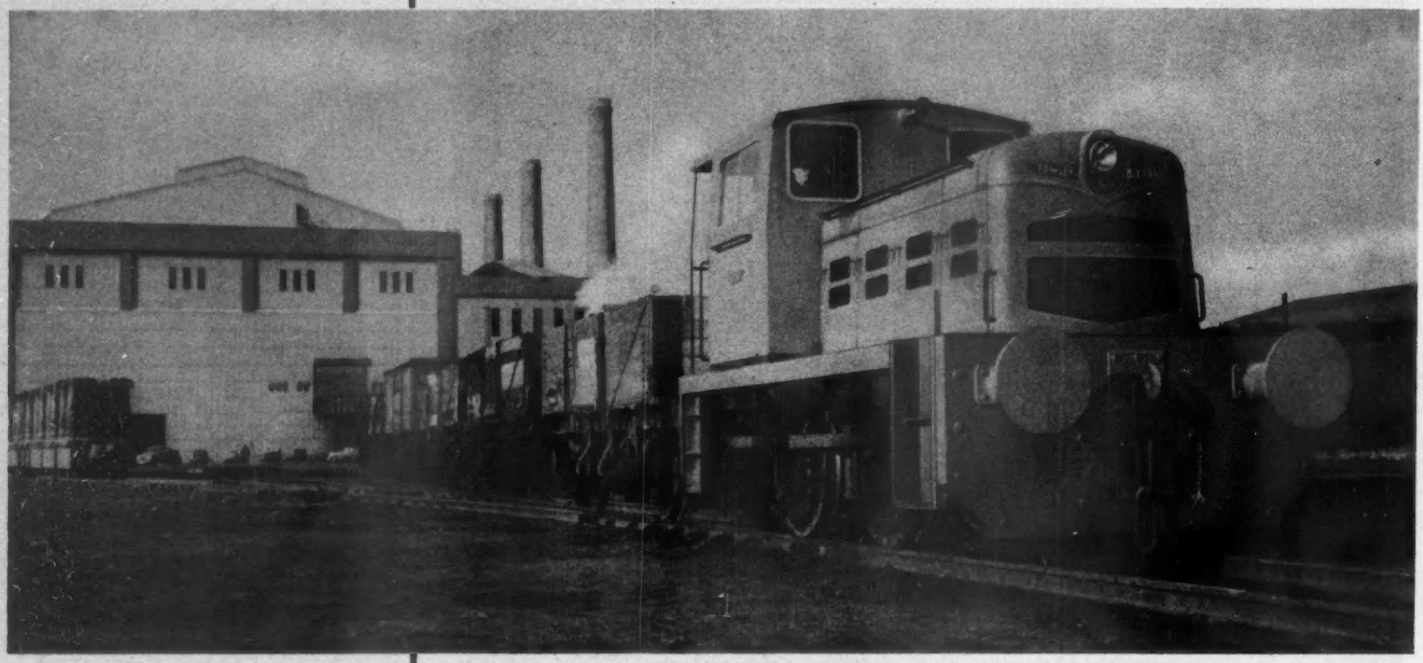
Fowler Diesel Locomotives



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Named the MD Range, these Fowler Locomotives from 150 B.H.P. to 400 B.H.P. have mechanical or hydraulic-mechanical transmission, giving rapid acceleration, finger tip control, smooth transition.

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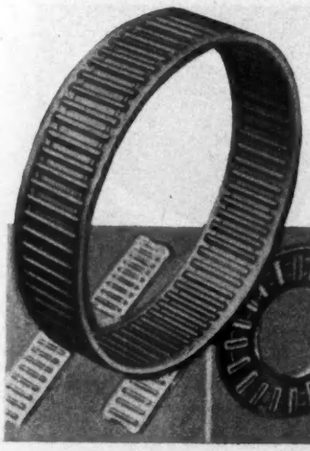

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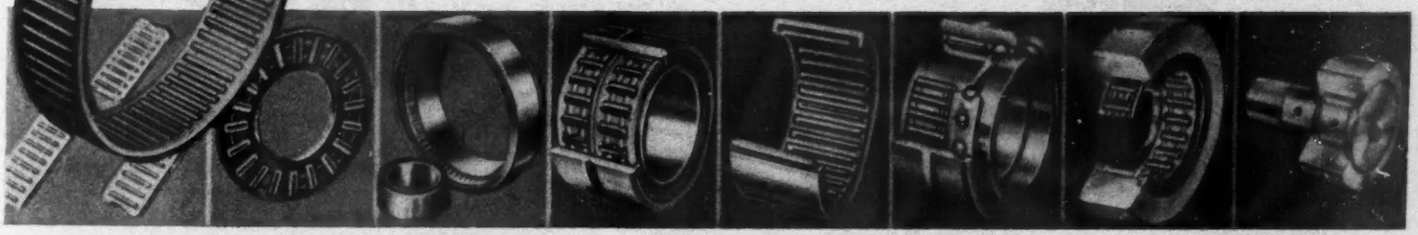

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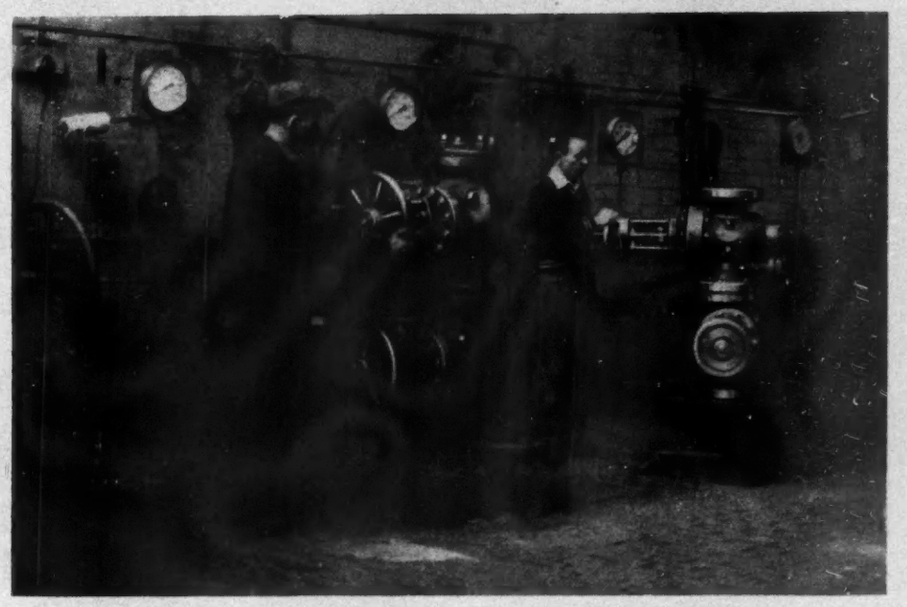

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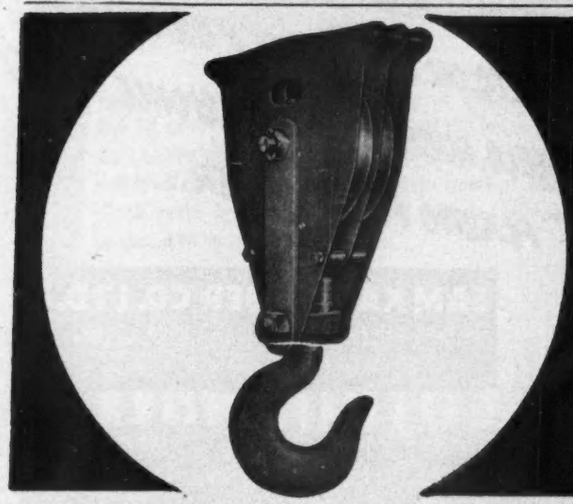

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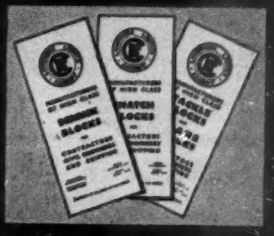

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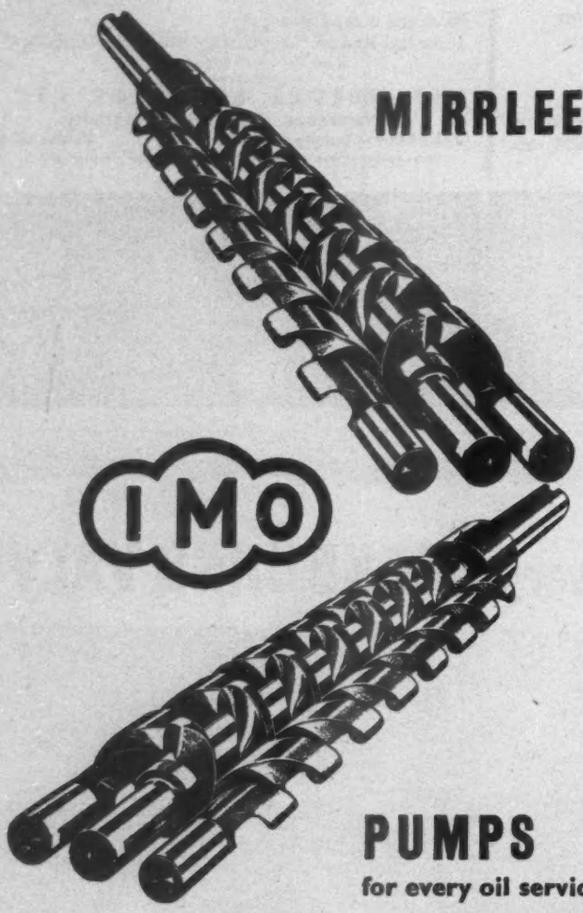

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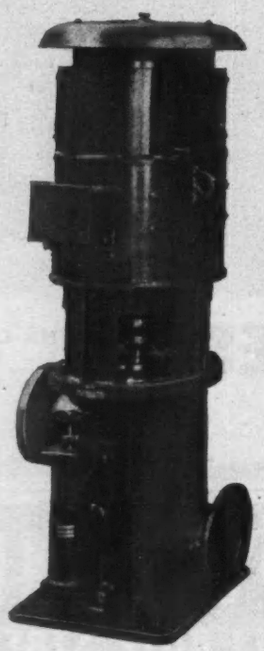

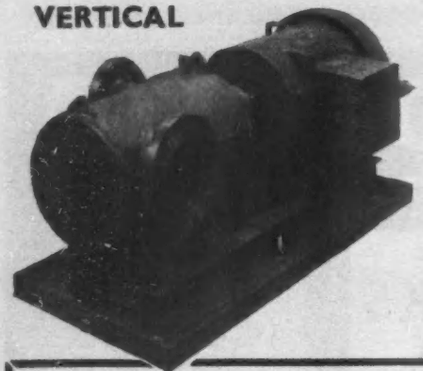

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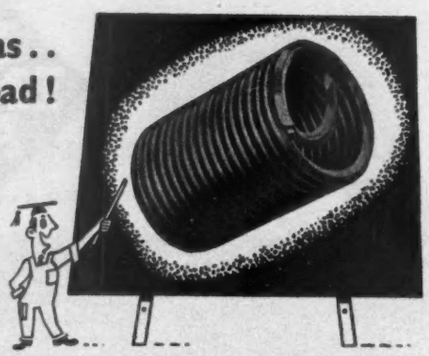

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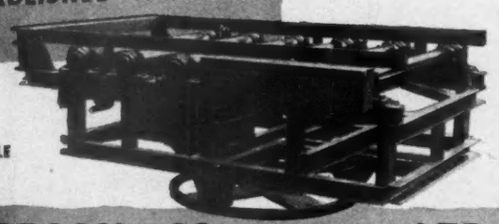

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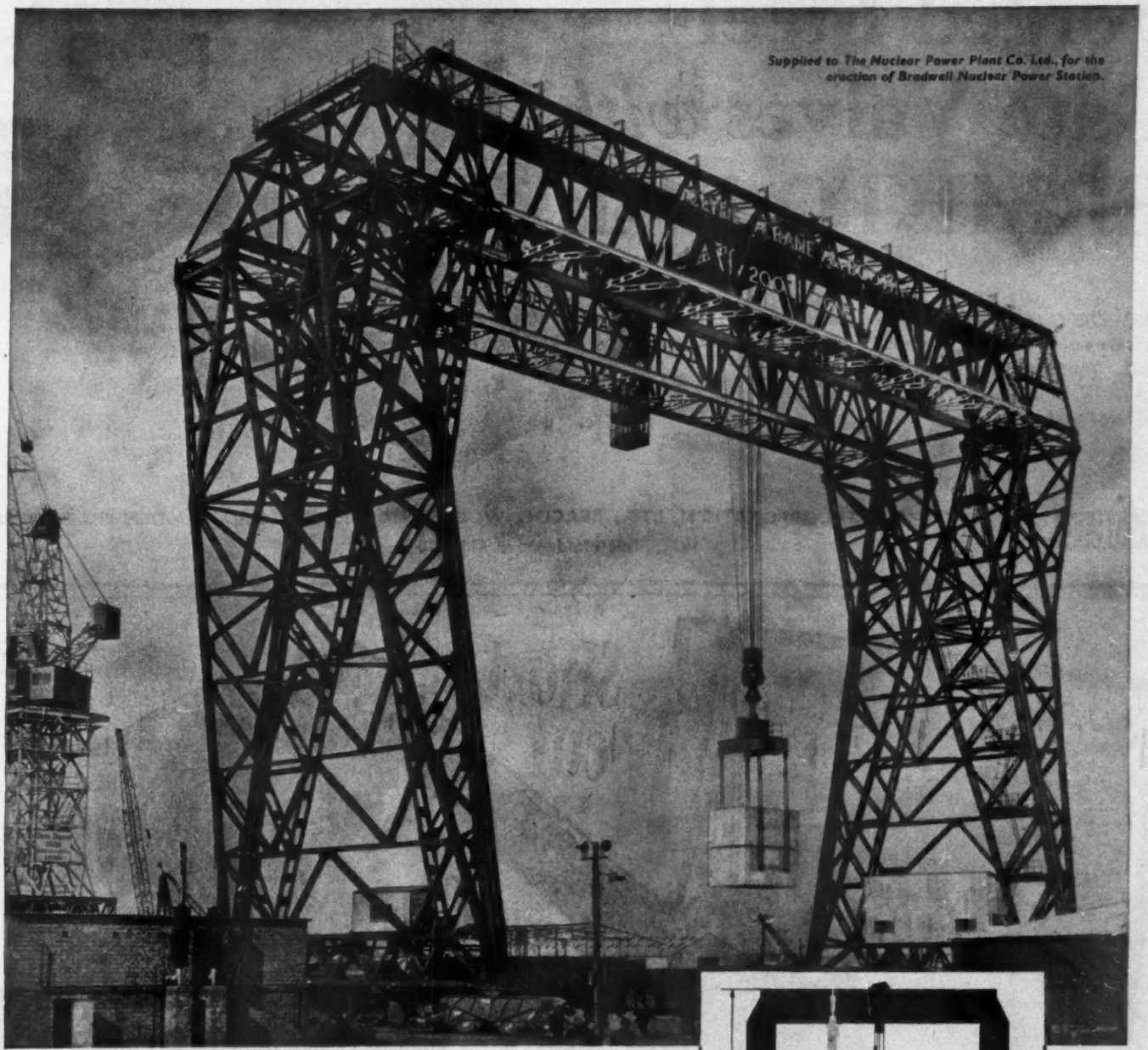

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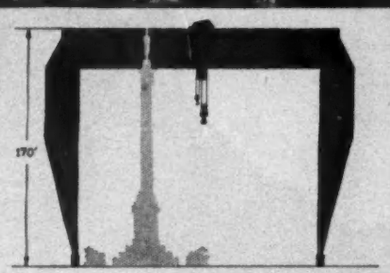

The Booth Goliath showing Nelsons Column on the same scale. Clearance from rail level to underside of bridge is 140'. Distance between rail centres 178'.

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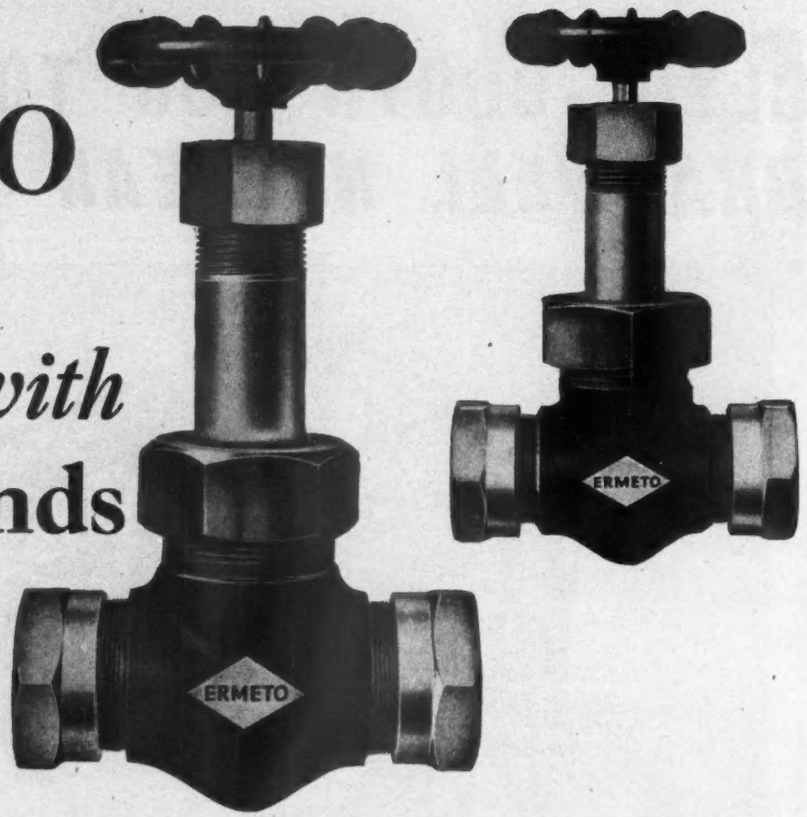

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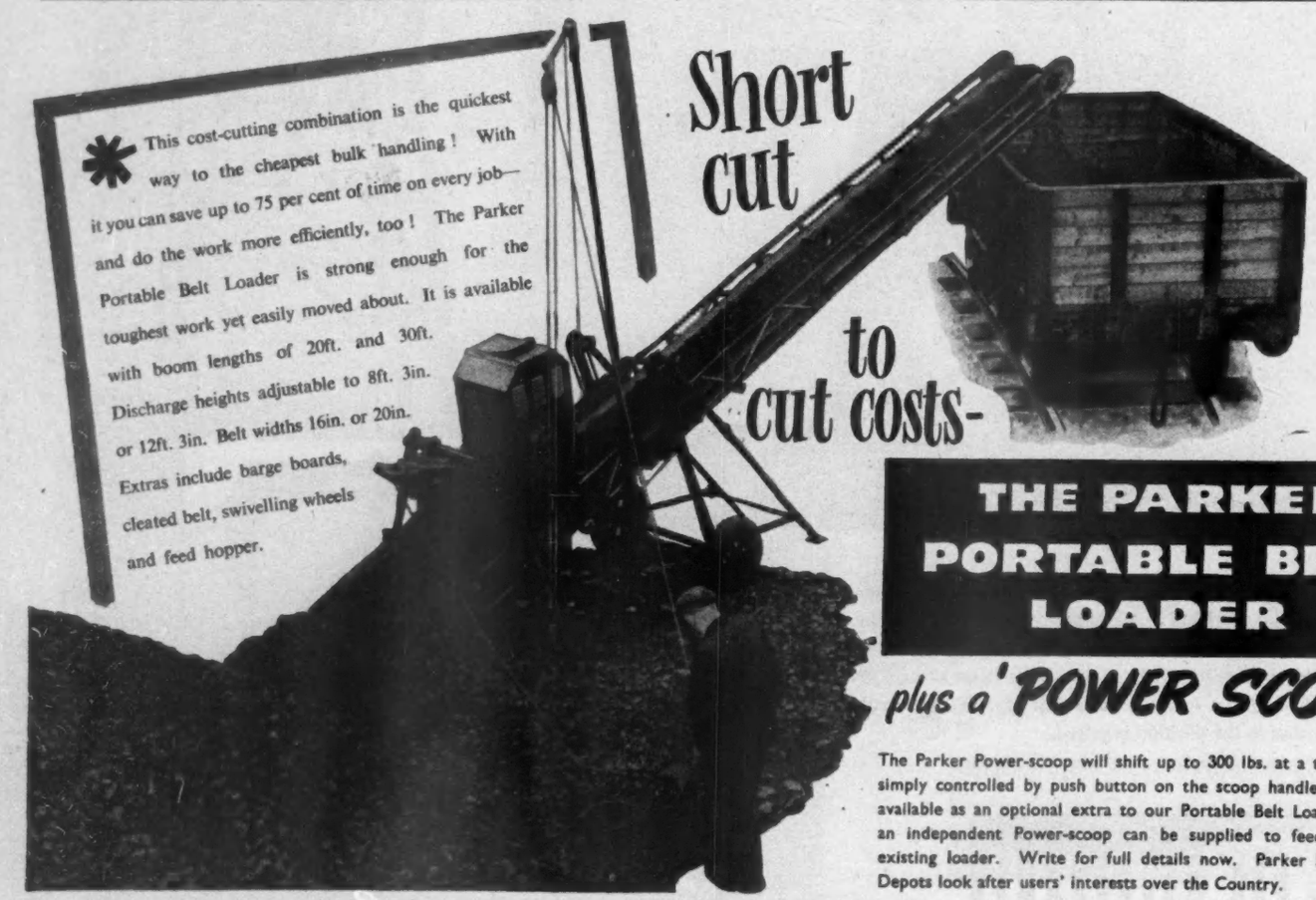

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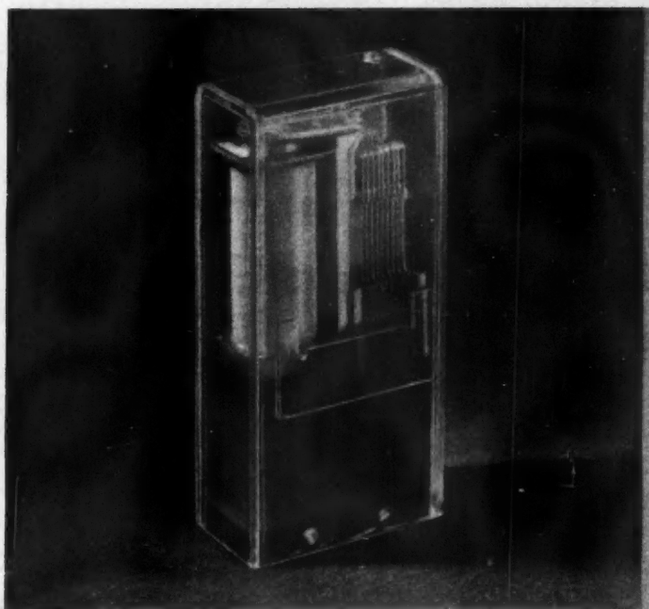

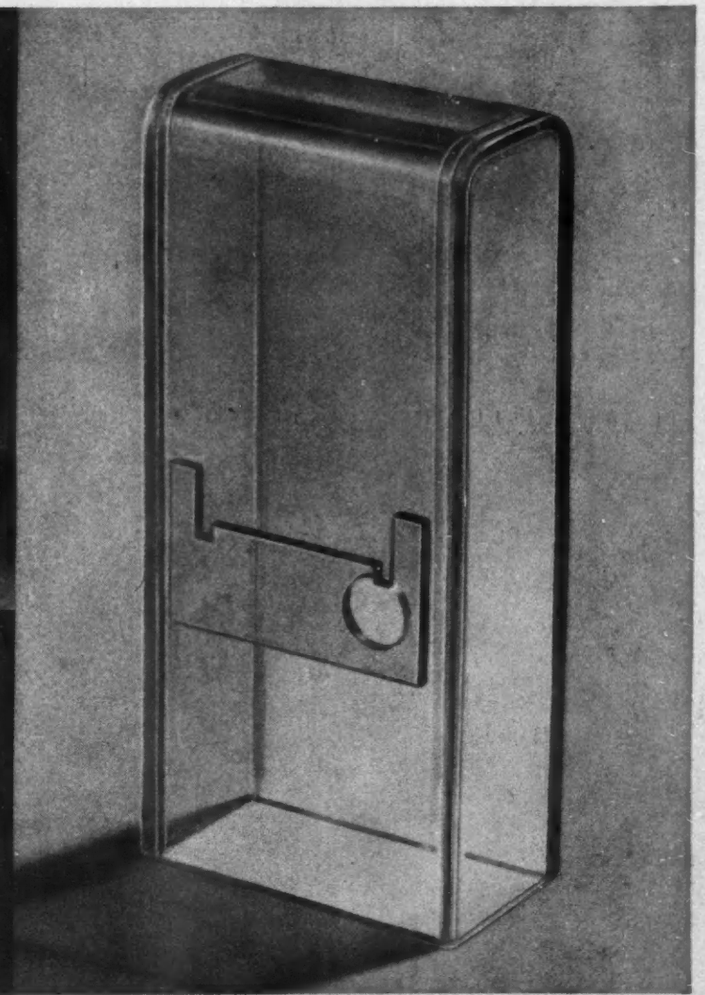

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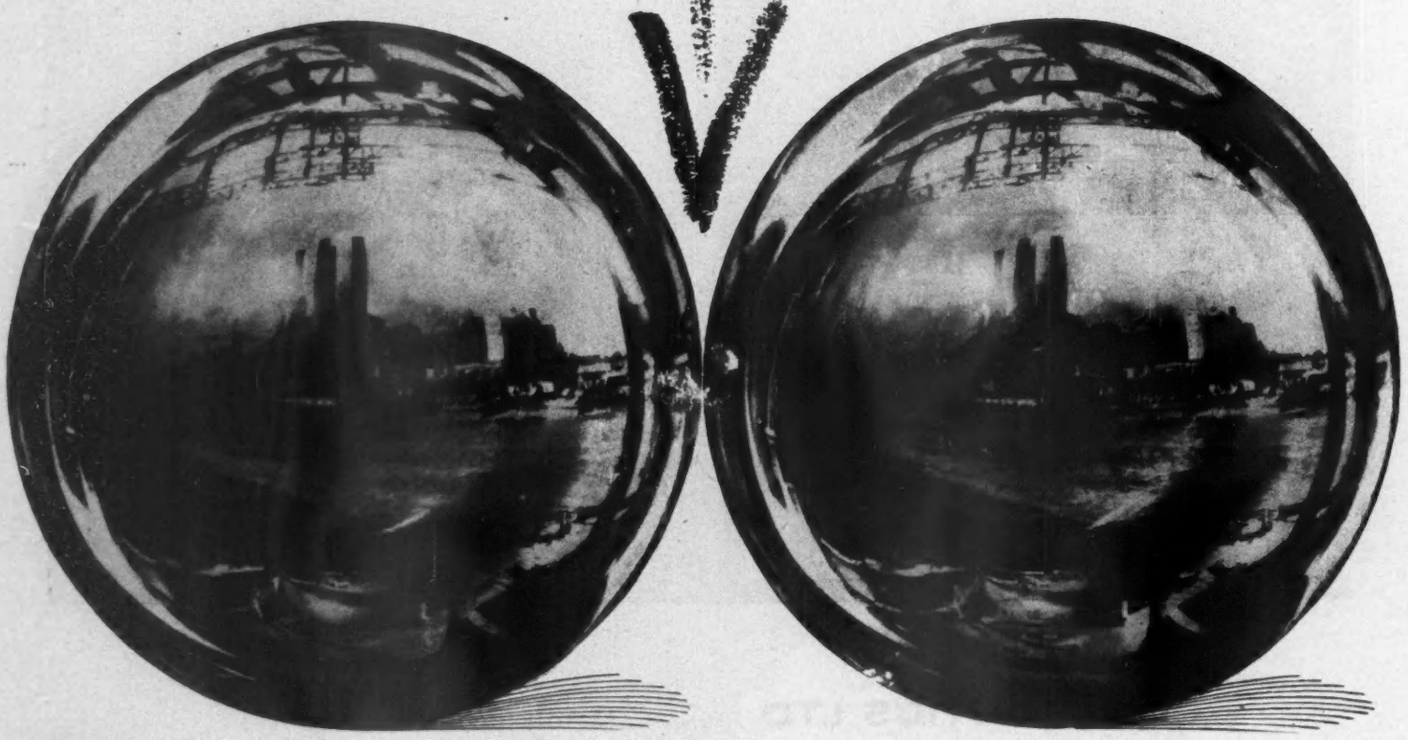

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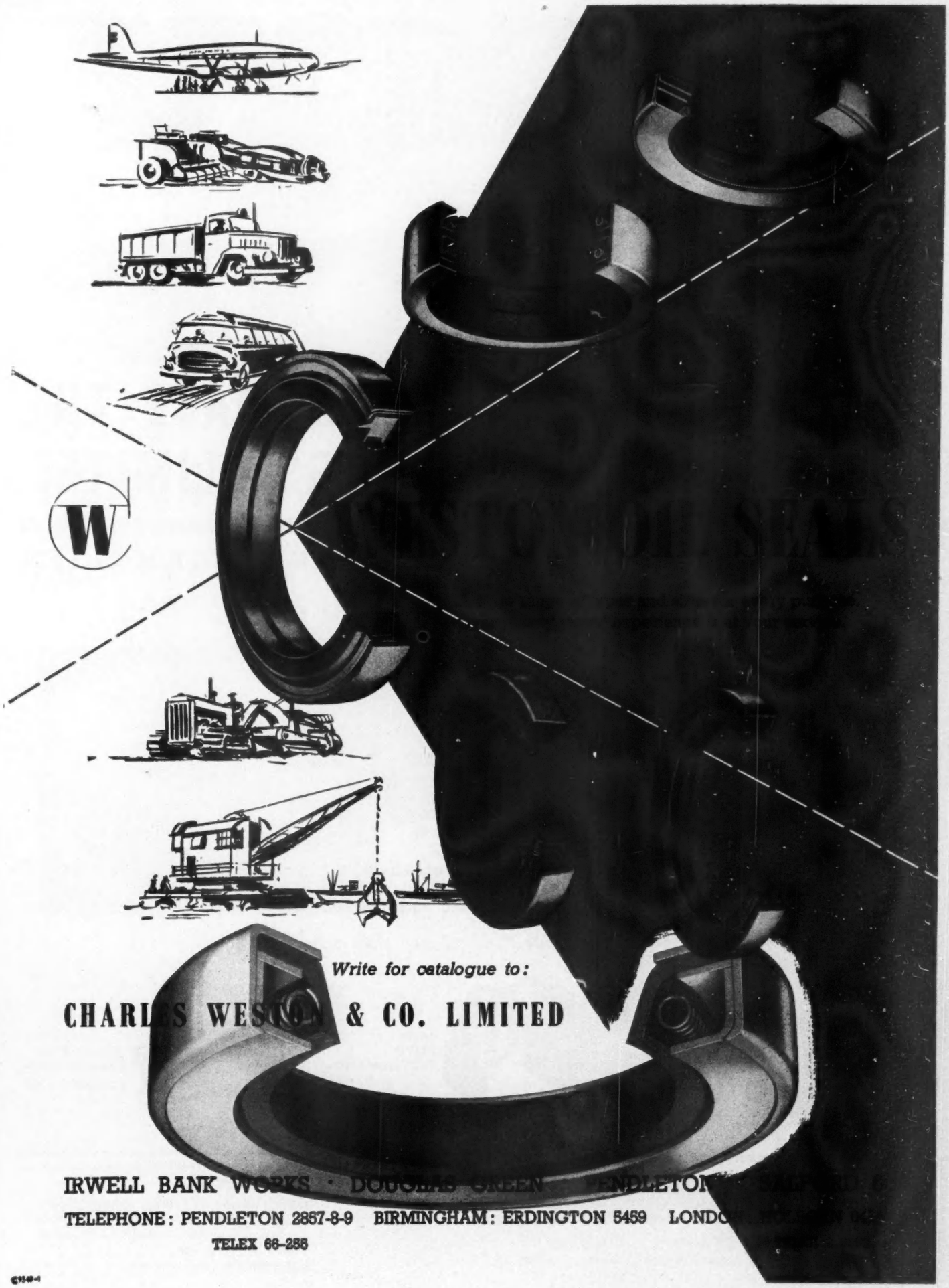

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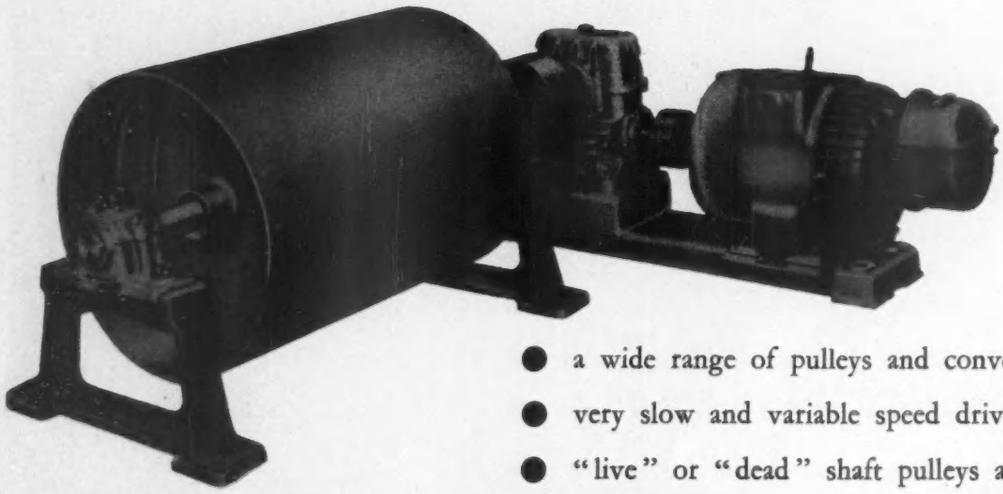

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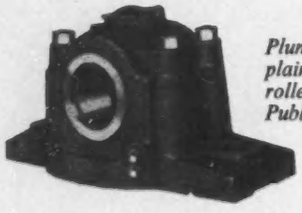

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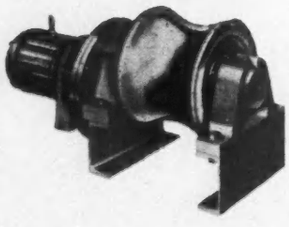

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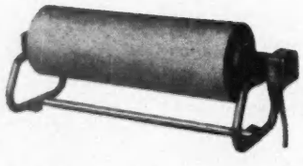

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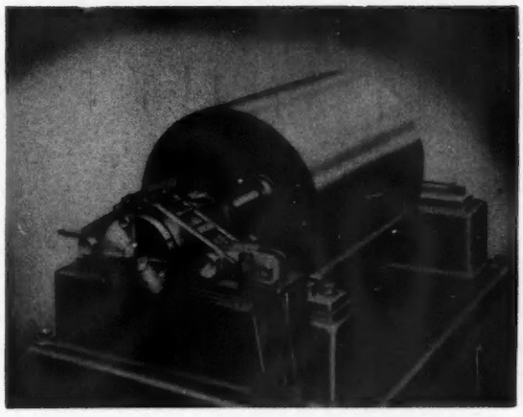

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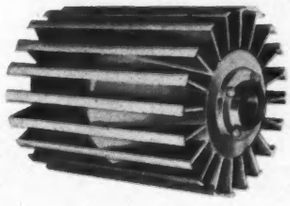

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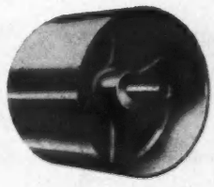

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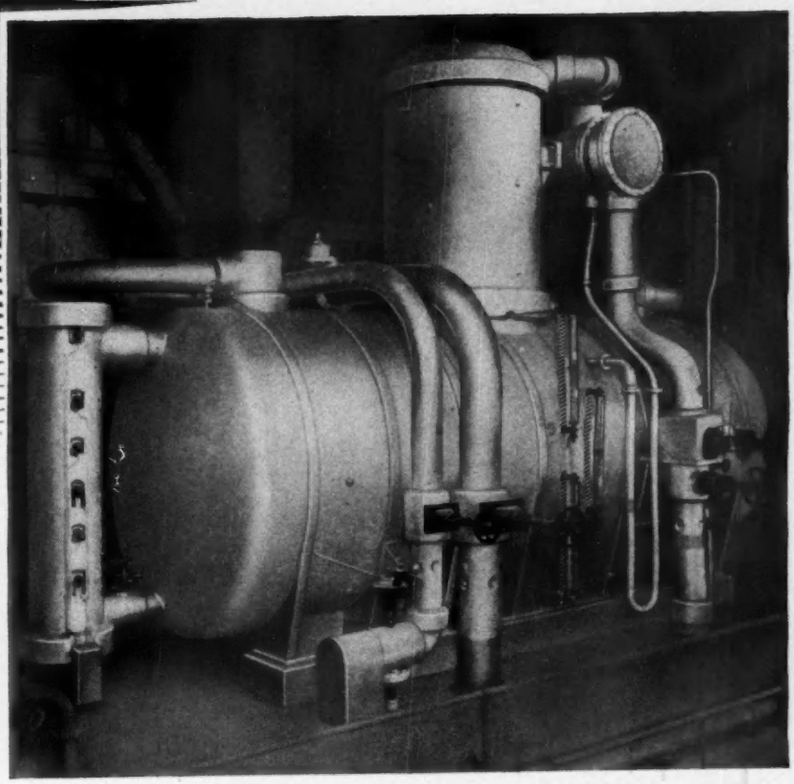

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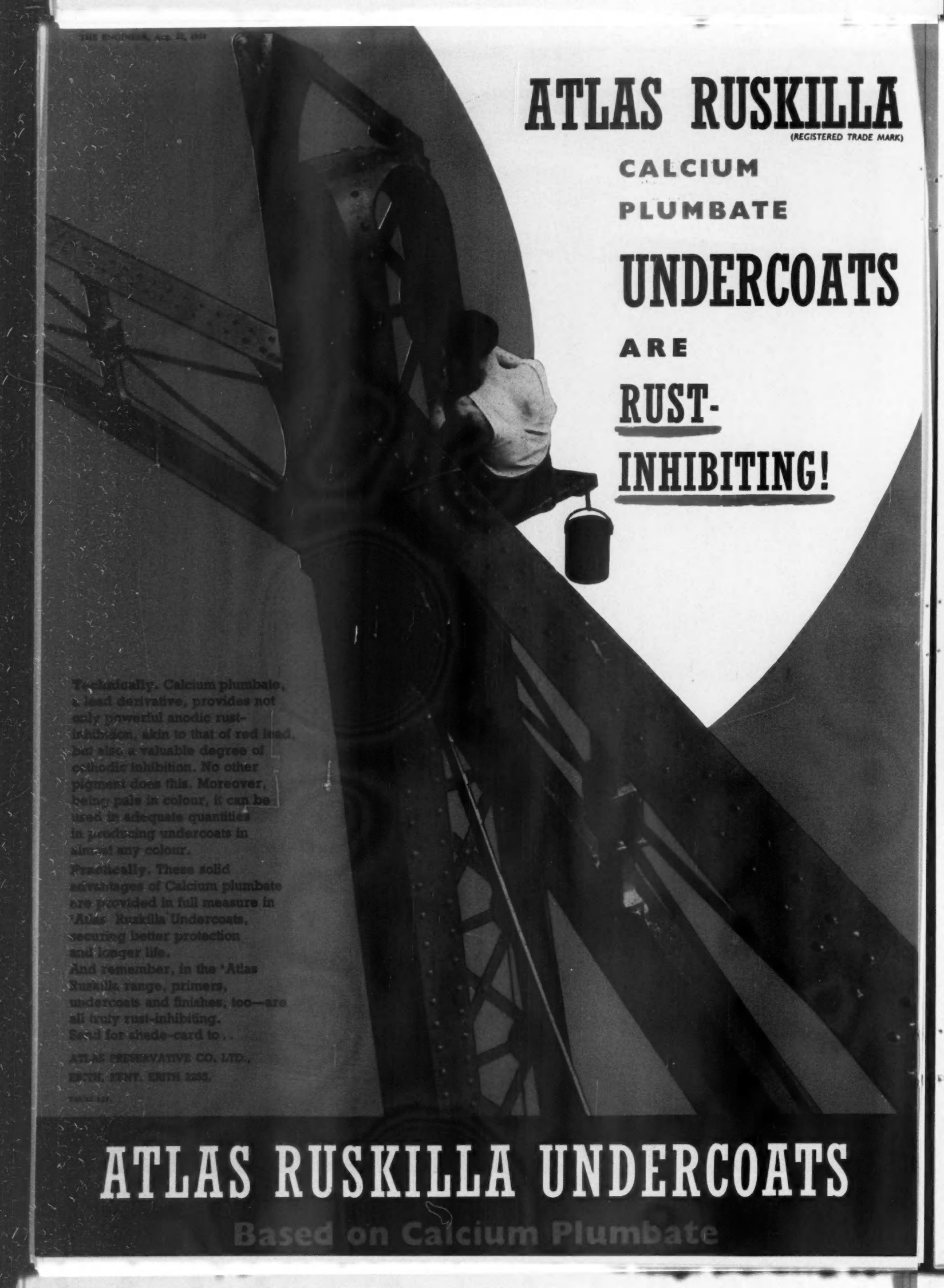
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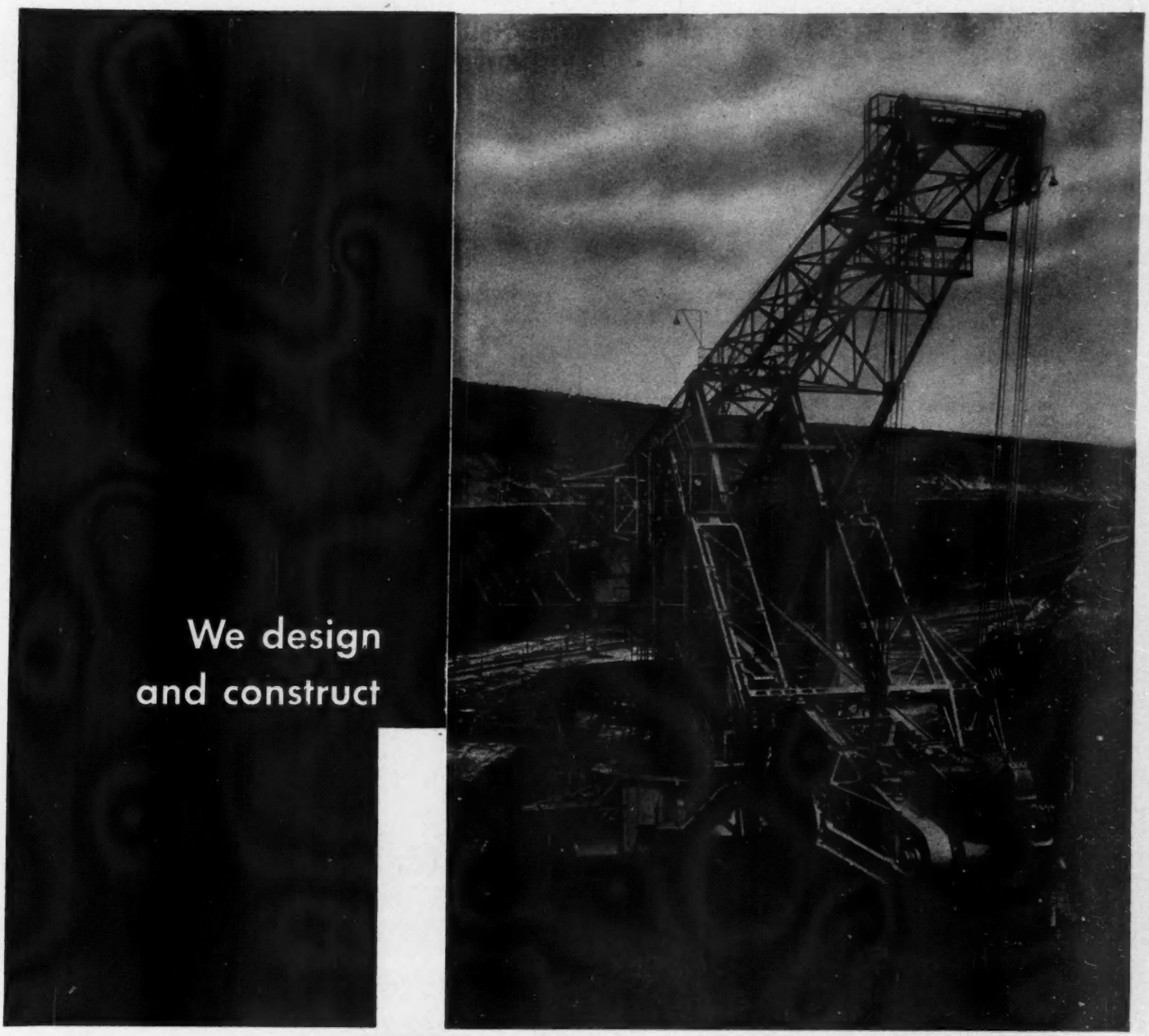

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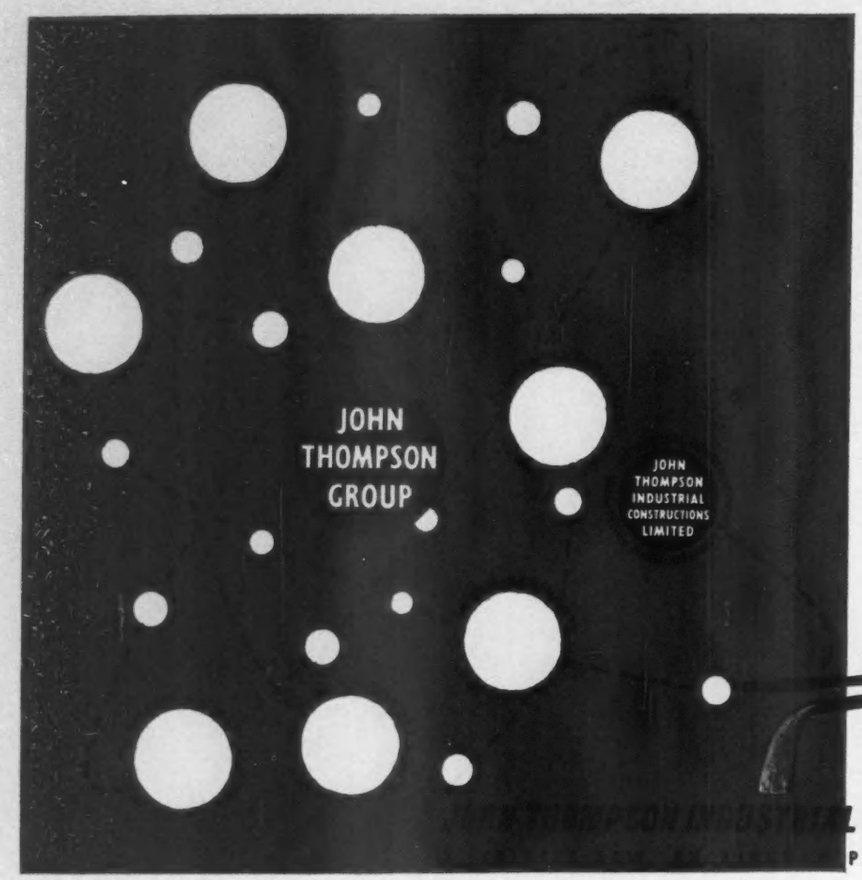

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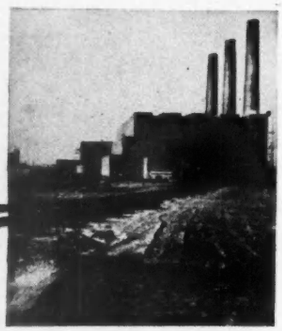

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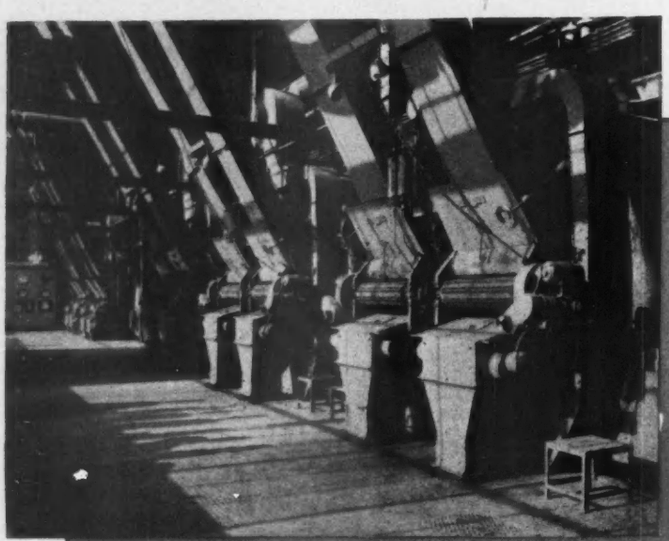

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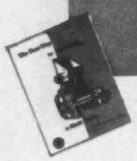

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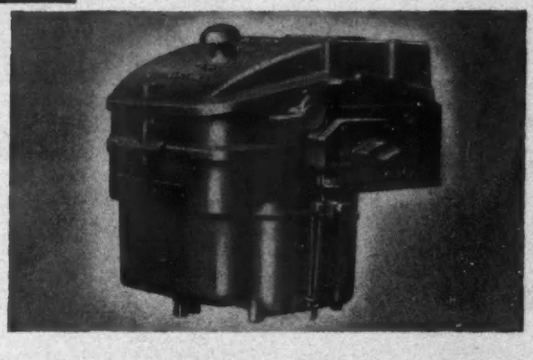

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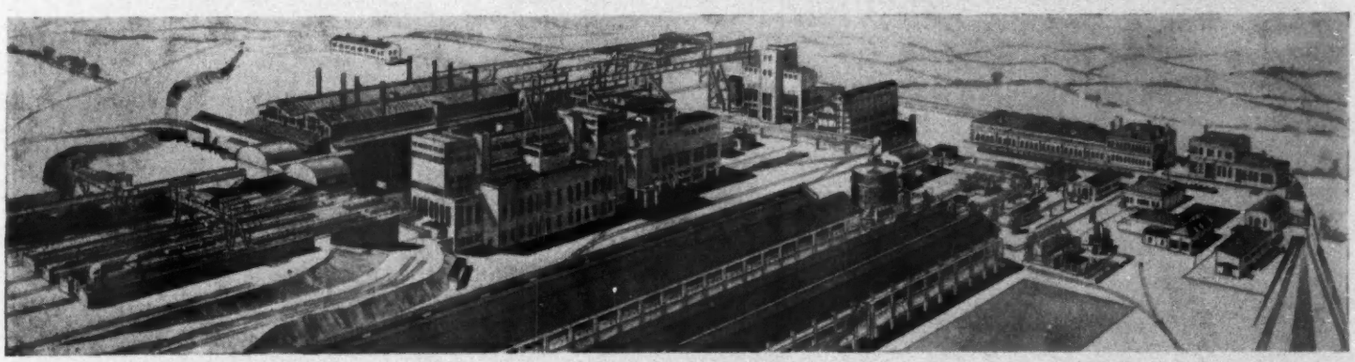

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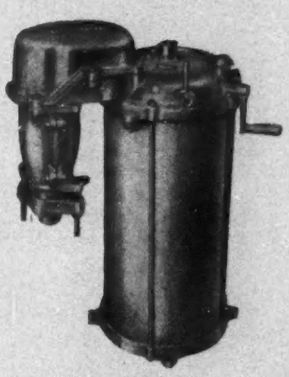

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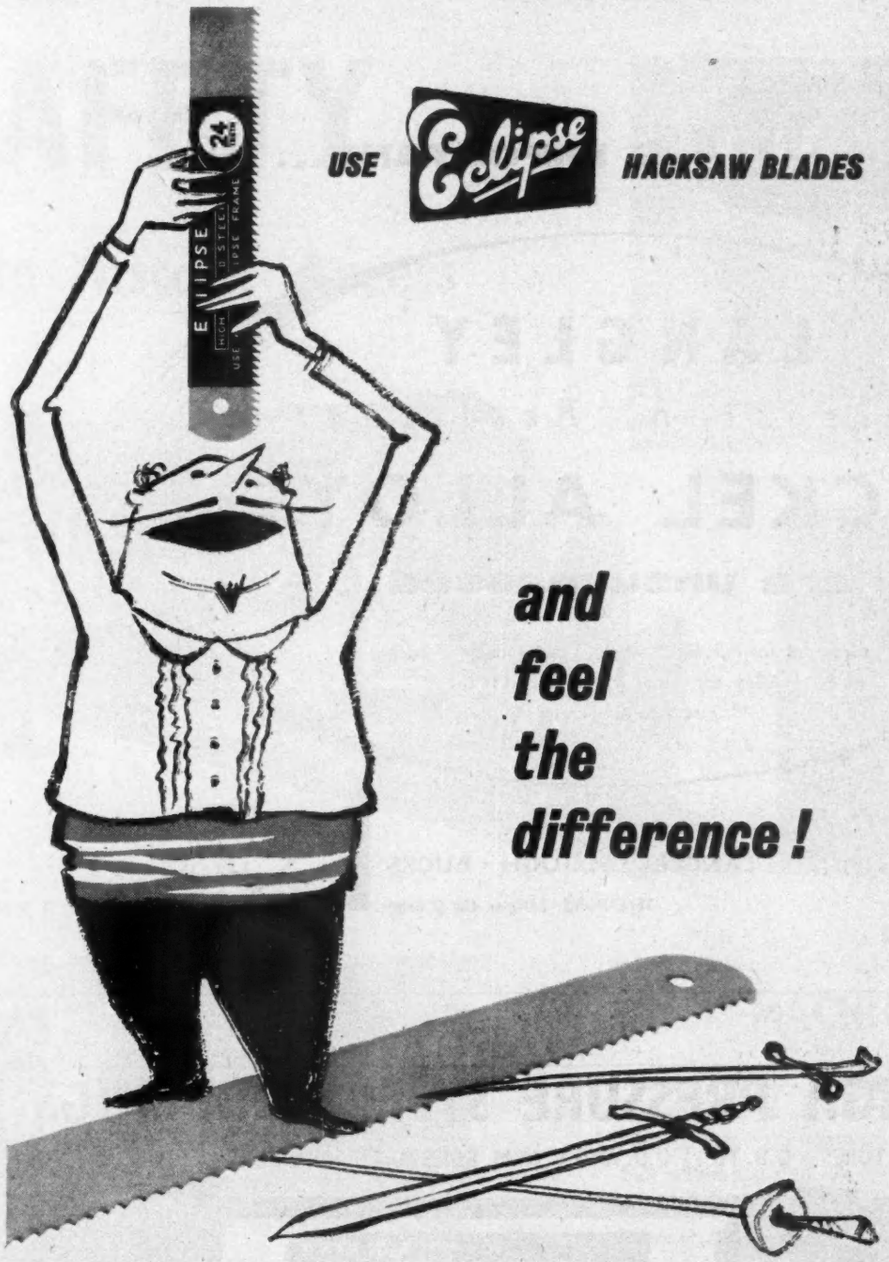

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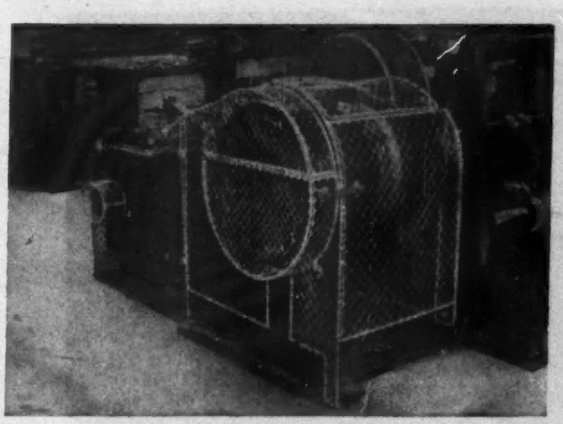

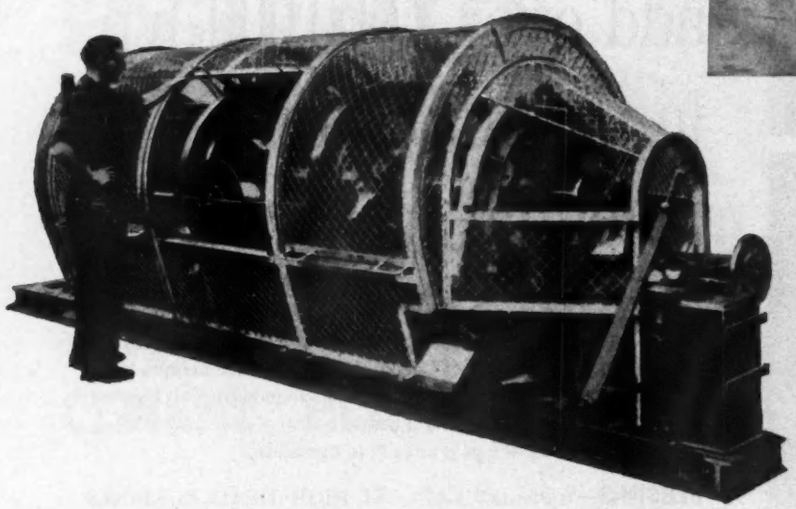

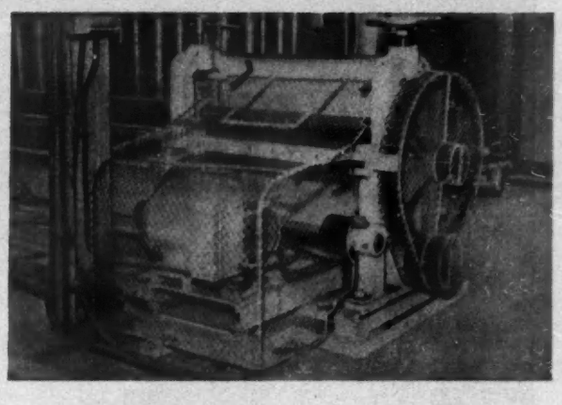

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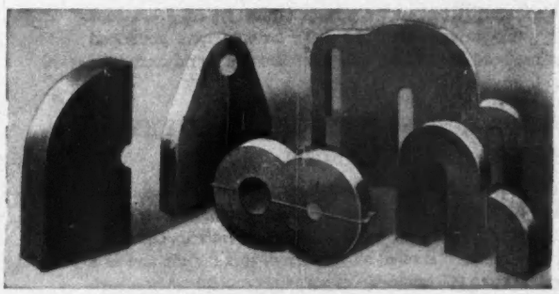

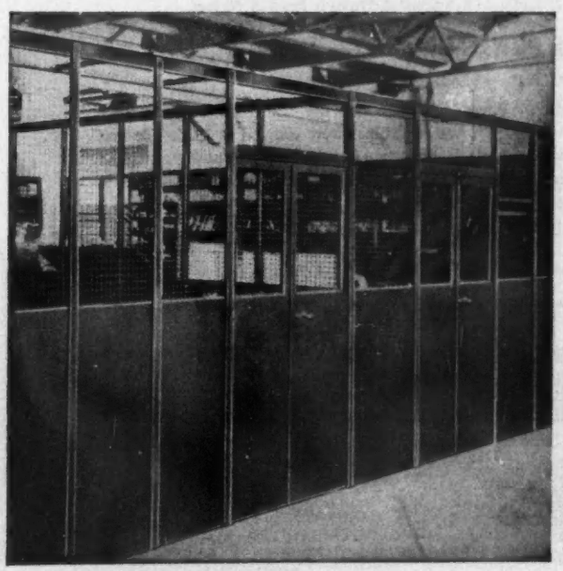

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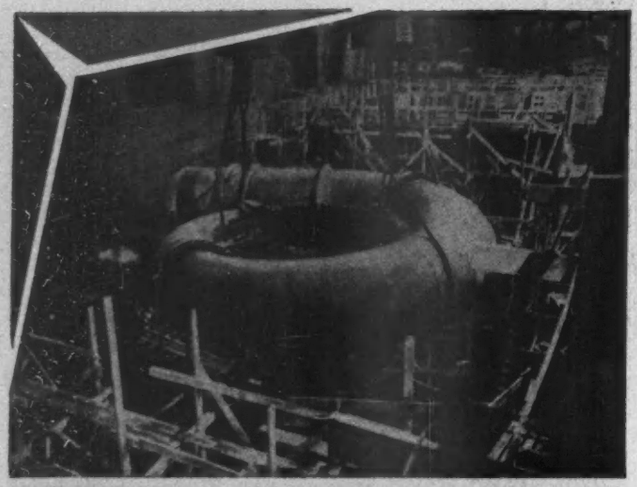

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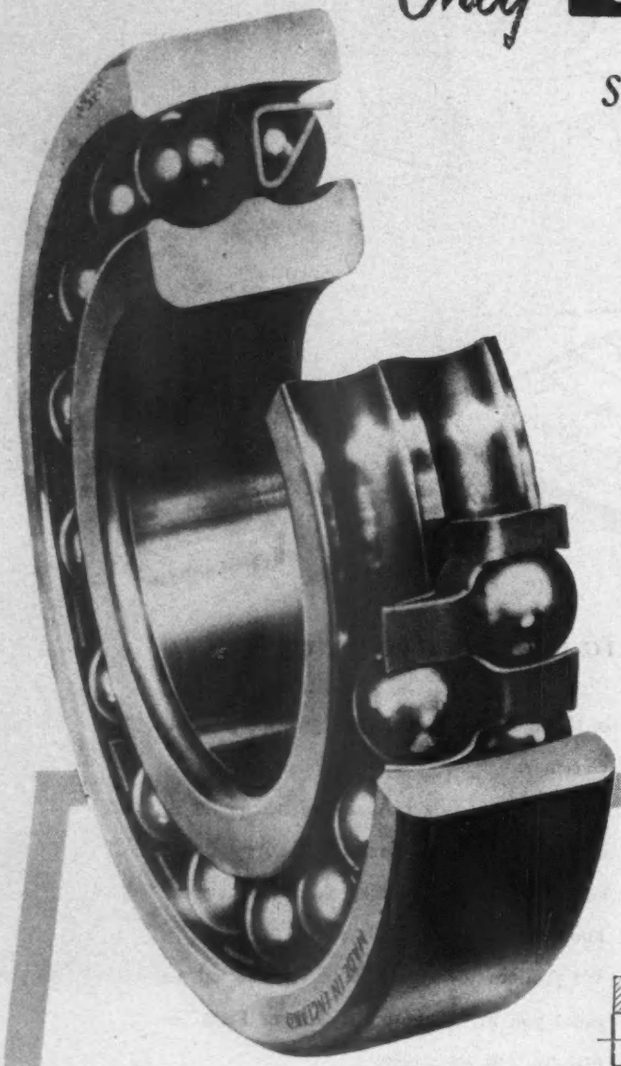

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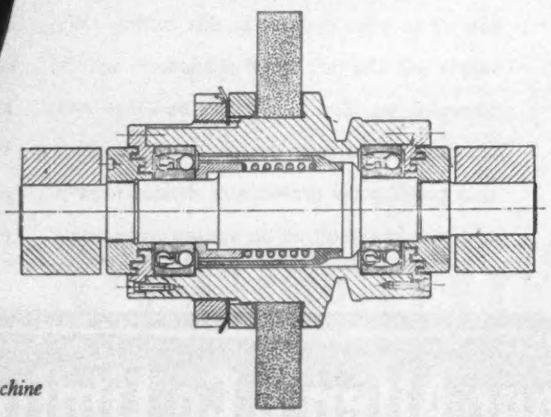

Bearing scheme for grinding wheel of leather shaving machine

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THE ENGINEER

No. 5352 AUGUST 22, 1958 VOL. 206

THE T.U.C. WONDERLAND

Once, when we were serving upon a committee of no very great importance, we ventured to make a humorous remark. The retort was immediate. A rich and reproving Scots voice called our attention to the fact that the subject before the committee was " not one for levity." Always, when we read a report of the General Council for presentation to the Trades Union Congress, we are reminded of that Scotsman. For it is apparently also the view of whoever it is that compiles the report, that the subject is " not one for levity." Indeed, year by year, not to put too fine a point upon it, the report gets stuffier and stuffier ! And this is as odd as the sun shining on the Walrus and the Carpenter in the middle of the night ; because the ordinary British working men whom the T.U.C. is supposed to represent are much more likely to bubble into laughter than to prove over-solemn, whatever the subject of discussion. We wonder, does the General Council, when in session, never laugh ?

A part of the difficulty in reading the report stems from the fact that it records a good deal of past history. Thus, there will be found reported in it in full all that the Council issued, during the year, in official statements about Government economic policy, its representations to the Chancellor before the Budget, and its reactions to the Budget when it heard it. Since Budget day, though there has been some change in the economic climate of the country, the report makes it clear that there has been no change of the Council's views, which remain strongly critical of the Government's actions. Yet, perhaps because those criticisms are set out in the report and in issued statements in so solemn a fashion, there is sometimes conveyed an impression that they are a bit synthetic. Like the Opposition in the House of Commons, the T.U.C. may, perhaps, regard it as its duty to know better than the Government what should be done. " Contrariwise," slightly to alter what Tweedledee is recorded to have argued, the T.U.C. Council thinks " if it was so, it might be; and if it were so, it would be. But as it isn't a Labour Government, it ain't. That's logic." Many industrialists, we think, would agree that the monetary weapon is a blunt instrument with which to fight inflation and that it unduly restricts that investment in the improvement of production plant which this country needs. But the alternative of direct control of industry from Whitehall, which the T.U.C. appears to favour, is surely worse. That system, in fact, results in the absurdity that junior clerks in Government offices pass judgment upon schemes drawn up by far more competent men earning many times their salaries ! Again, we can concede that the cause of inflation is not wholly to be found in annual rounds of wage increases unjustified by increases of productivity. But it is quite impossible to suppose that those increases have nothing to do with it at all ! Nor can one admit that the Government is acting as wrongly as the T.U.C. would have us believe, in attempting to influence wage negotiations and arbitration tribunals by making certain economic facts known to all the parties involved. However, it may be a sign that grace is descending upon the T.U.C. that, in the present report, there does appear a more direct admission than usual that the economic state of this country cannot be insulated from that of the world. For, rather unnecessarily, the Government is urged to take the initiative in seeking international agreement to ensure economic expansion and restore world trade. But, unfortunately, this sensible realisation of the true economic situation of the country has to be set against the fact that two pages later the Council announces its determination to have nothing further to do with the Cohen Council on Prices, Productivity and Incomes, provoked apparently by that Council's rejection of the T.U.C. submissions in its February report.

But if, in the economic sense, one must feel that the T.U.C. opposes the Government as much because it is Conservative as because it is believed to be wrong, there are other parts of the report which make more profitable reading. The Council has, for example, been closely interested in the proposals for a Free Trade Area in Europe, and there can be no doubt that its suggestions as to certain clauses which, in its view, should be written into any treaty, will help the Government during its negotiations. Again, it is interesting to find recorded the results of a Council inquiry from unions affiliated to the T.U.C. about automation. The replies from the unions made it clear that they were not being subjected to acute problems which arose from the introduction of automation and which were beyond their ability to deal with in any reasonable satisfactory manner. A great deal of other admirable work is recorded in Section G of the report, " Production and Industrial Development," though not all of it may be wholly welcome to industrialists. The Council seems inclined to accept as true, for example, criticisms by the Confederation of Shipbuilding and Engineering Unions of the machine tool industry. At least, it is trying to get the efficiency of that industry discussed on the National Production Advisory Council on Industry. But a growing interest in production problems and in problems of management, if only it can be made to filter down from the Council to individual unions, and within individual unions, to branch secretaries and shop stewards, could do nothing but good. For it is absurd, in these enlightened days, that there should be opposition from the labour side to management proposals for higher productivity, since higher productivity profits everyone. Better appreciation at shop floor level of production problems could lead to more reasonable negotiation about redundancy. For anyone who believes, as, apparently, the A.E.U. is inclined to believe, that it should be possible wholly to prevent redundancy can only be compared to the White Queen in " Alice Through the Looking Glass." Did she not tell Alice, with pride, " Why sometimes I've believed as many as six impossible things before breakfast." Redundancy there must sometimes be. The object of negotiation should be to mitigate its bad effects.

POWER TO BARGAIN

An agreement was concluded recently, between the United Kingdom Atomic Energy Authority and the Power Reactor Development Company of Detroit, U.S.A., for the exchange of information on the development of fast-neutron reactors. The embodiment of British ideas on these plants is the reactor at Dounreay, and this is now so well known as to have become almost a symbol of atomic energy in the public eye. It is as if the general mass of the people had just caught up with the nineteenth century conception of an atom as a simple sphere, and found an adequate monument to this hypothetical entity in the great steel vessel that contains the reactor! The "Atomium" at the Brussels exhibition is perhaps the latest instance of this progress of the popular scientific consciousness. Photographs of both the Caithness establishment and the body-centred cube at Brussels have been taken and published almost to excess, though each is admirable in its own way. Latterly, however, one has heard complaints that the beauty of the Dounreay structure is only skin deep, and that operations within the great sphere are already some six months behind schedule. To admit this is not to admit that the Authority has had to turn to the Americans for help, or that the manifest difficulties of the undertaking are too much for the staff to solve. Far from it. We have reason to believe that there is something to be given and something to be taken by both parties to this new agreement. In some matters the Americans may be a little ahead, and in others the lead is on this side of the Atlantic. The Americans and the British are the only ones to be experimenting with fast reactors, to the best of our knowledge (we cannot see through the iron curtain), and it seems only right and proper that two nations so closely allied in almost every way should pool their knowledge on such an advanced and laudable civil enterprise. We know, for example, that energy might conceivably be released so swiftly if some malfunction occurred that the fuel could melt and accumulate beneath the core. At Dounreay the fissile metal is prevented from running together in such circumstances by causing it to form small sub-critical groups. This is a fairly obvious precaution. But the energy released in a power surge must be calculated, and we understand that the British technique of calculation has been referred to—and preferred to their own—by the Americans. On the other hand, the technology of liquid-metal cooling is possibly more advanced in the United States than it is in the United Kingdom, and in this case the traffic of information may well be eastward.

It is interesting to contrast the two ways in which we barter knowledge with our brethren across the Atlantic. The present five-year agreement with the constructors of the Enrico Fermi I plant is one example. Here a pair of equals is comparing notes, as it were, and each party is taking a hint or two from the other. In the other case the two parties have followed completely different routes and evolved separate technologies. Each has had its success, and the acquired know-how of each would be useful to the other. So clearly there is a good case for a bargain. We refer, of course, to the evolution in the United Kingdom of the gas-cooled graphite-moderated reactor, and the development in the United States of the pressurised water reactor. It may well turn out that the former, in an advanced guise, will become the accepted kind of reactor for land power in many parts of the world, while the latter will predominate for marine propulsion. One is tempted to speculate as to which of the types of bargain produces the richer fruit. Have the two teams working on fast-neutron reactors overlapped so far that some of their effort has been wasted, and would it have been better for them to collaborate fully from the beginning? Perhaps it is, after all, a good thing for the national atomic energy authorities to go for all they are worth at markedly different projects. Such international competition may well be healthy—between friendly nations—and, indeed, it is certainly healthier than the race between insulated teams striving for identical objects. Even if this is true, however, we must take care that no important enterprise is omitted simultaneously by all of the friendly nations. As long as one member of the western world has a pressurised water reactor or a Calder Hall, it may not so very much matter which. There may be a lesson here for those who now wish to initiate a British satellite programme, but if it is to be useful the lesson must be clear on both sides of the Atlantic. Would the United States be exchanging atomic information with this country, one wonders, if there had been no large-scale effort here in the first place?

HYDRAULICS RESEARCH

When we were somewhat younger, which for a journal as old as this means forty or so years ago, doctors had to rely upon a prodding thumb and enquiries as to whether it hurt, to discover whether bones were broken or duodenal ulcers had developed. But to-day one is hurried off to the X-ray department at the hospital almost before one has time to complain about a pain. Something analogous has happened in hydraulic engineering. In the past, engineers built harbours and docks, advised upon dredged channels, constructed training walls, put down foundations for bridges and river-side structures, reclaimed land from the sea and did a good many other things besides, out of an intuitive perception of the way in which water was likely to behave. But nowadays the trend is all towards trying out a proposal on a hydraulic model first. The consequence is that there has never been really enough space available for the Hydraulics Research Station to carry out the work offered to it. That "Station" was set up in 1947 in temporary accommodation at the National Physical Laboratory; and when in 1949 large-scale model experiments were begun into siltation in the Thames estuary, the work had to be done in a shed at Victoria Dock. In the same year Howbery Park was acquired; but it was not until 1951 that more adequate buildings designed especially for the work to be done began to come into use. Only since 1955 has a great hall, almost clear of obstructions and measuring 300ft by 200ft become available for the construction of models. It is significant of the demand upon that space that the Hydraulics Research Board, which issued its 1957 Report, in conjunction with that of the director of the station, during the past week, reports a conclusion reached last year that "good use" could already be made of additional floor area. There is plenty of evidence that good use is being made of the space up to now available. Out of the combined field and model study of the Thames estuary, for example, there has arisen the firm recommendation that material dredged from the river should be dumped on land, since if dumped in the outer estuary it will be carried back up the river by the tides. Again, a preliminary finding, from models of the River Trent intended for a study of proposed schemes for alleviating flooding, relates to a desirable change in the design of an embankment and viaduct to carry the London-Yorkshire motorway across that river's flood plain. A model study of the estuary of the River Lune strongly

suggests that the construction of training works in an estuary in which silt is present will " almost inevitably lead to some loss of energy and cubature, hence to some overall deterioration." This, which may prove to be a truthful generalisation, adds force to a conclusion of the Board that " when it becomes possible, more background research should be undertaken." But when will it be possible ? The impression conveyed by the report is that the pressure upon the station to study specific problems will always, within the foreseeable future, be so high that only a determined decision by the Board and its director will suffice to make it possible for more background research to be, in fact, undertaken.

LUNAR PROBES

In the short space of a mere twelvemonth the setting up of an artificial satellite in an orbit has ceased to be a wonder calling for banner headlines in the daily papers. A column at most was as much as the latest American satellite to be launched attracted some weeks ago. But the shooting away from the earth of a small body which it is hoped will circulate around the moon is likely to bring back the headlines, once it has been done successfully. Nor should the Americans prove downcast because their first attempt proved a failure. For the task is substantially more difficult than that of setting up a satellite and the chances that something may go wrong during launching or flight are large. The significant factor to notice is that it is already within man's competence to fling an object so far off the surface of the earth that it can reach the moon. Whether or not he can fling it so accurately that it will circulate round the Moon remains, of course, still to be proved !

Another factor that is significant is that though American (or perhaps Russian) engineers will have sent up what is termed the first " lunar probe " international co-operation is essential if much is to be learned from it. Over in this country, for example, those who operate the great Jodrell Bank radio telescope were standing by when last Sunday's attempt was made in the U.S.A. For that telescope is peculiarly well fitted to pick up radio signals that will be emitted by the lunar probe and to provide information about its precise bearing from the earth and thus in combination with other readings fix its position in space. Incidentally, though the intention is that the lunar probe shall circle the moon there are possibilities that it may " miss " and career off into space. The Jodrell Bank telescope would be capable of receiving transmissions from it at distances of a million miles.

When a " lunar probe " first circles the moon—whether it is a Russian or an American device—the daily press will be quite right to regard it as first class news. For a lunar probe will prove an object significantly different from a satellite. The primary purpose of satellites is, at present, to contribute to the International Geophysical Year; that is they are improving scientific knowledge about the atmosphere of the earth, about the radiations that fall upon it and their effects and so forth. Effectively satellites are still earthbound and contribute knowledge primarily about factors affecting the earth. The lunar probe, however, will be primarily designed to gain information about a body other than the earth. As Professor Lovell has put it the lunar probe " is a mere stepping stone to the future investigations when we succeed in getting similar probes many millions of miles into space so that we can explore the atmospheres of the planets and perhaps get more information about the surfaces of the planets such as Venus which are completely cloud covered."

INVENTIVENESS

At Brussels recently there was held an International Inventors' Exhibition. For some reason—probably because we are too insular a people—nobody in this country seems to have taken the slightest interest until a mere few weeks remained before the Exhibition opened. Then, largely as a consequence of a visit to Brussels by the Secretary of the Institute of Patentees and Inventors, inventors in this country woke up. Somehow or other—by hook rather than by crook we suspect ! —fifty British exhibits were hurriedly gathered together. They were included amongst 1500 other exhibits from all over the world. In those circumstances not much could be expected. It is therefore really remarkable to record that a British inventor took the Grand Prix—the top award—and five other British inventions took Gold Medals ! A variable speed motor took the top award and a crease-resisting woollen cloth, a multiple hand tool, a collapsible stacking unit, a method of storing blueprints and a pressurised assembly cabinet the medals.

History, of course, relates that a really surprisingly high proportion of the major inventions which have benefited mankind originated in these islands. Anyone who doubts it should penetrate into one of the open spaces beyond the British Government pavilion at the Brussels Exhibition. There many examples are enumerated. As engineers there come to our minds at once such names as Newcomen, Savery, Watt, Trevithick, Nasmyth, Whitworth, Parsons, Akroyd Stuart, Bessemer, Faraday, Fleming and many others. The British people continue to contribute in this way. But what is far less appreciated here is that besides many great inventors this country has produced also a very large array of minor inventors. No doubt it was the greater ones that made the minor inventions possible. Yet without the minor inventive ability thus revealed our lives would be less comfortable and in many ways less richly varied. Obviously, to judge by the results at Brussels British people remain as successfully inventive as ever. Long may they remain so !

The Engineer— 100 Years Ago (AUGUST 20, 1858)

" RAILWAY ENTERPRISE "

" Is there any such thing as railway enterprise at the present day ? It is to be feared that it has all but died out from among us. Not only do commercial men now eschew railway undertakings as investments, but those great and hitherto most confiding classes—half-pay Army and Navy men, widows, guardians, trustees, and annuitants of every grade, have lost all faith in the safety of railway property. Directors, engineers, solicitors, secretaries, and all officials, even down to the meanest porters, are eyed with the greatest mistrust. Nothing they propose is listened to, nothing they say is believed, nothing they do is right. . . .

" Public attention has been forcibly called within the last few days to the state of railway matters in this country, by the report of the directors of that broad road to ruin—the Great Western Railway. It is needless for us to give the history of this undertaking, as it is generally well known. Suffice it to say that about half its capital, or nearly £12,000,000 sterling, this year pays nothing ; the whole of the revenue being swallowed up in the payment of expenses and interest on the preference shares or bonded capital, which interest amounts to about double that upon which money can now be obtained. The Great Western ' system ' has swelled from a modest line of 118 miles to its present length of 466 miles ; and in proportion as it has increased in length, so have the profits on the undertaking diminished. We have the length of the line increased in the ratio of 4 to 1, and the revenue now allowing of interest being paid at the rate of 2½ per cent, or thereabouts, upon the total capital, instead of, as formerly, 10 per cent ; in other words, the profits have decreased in the ratio of 1 to 4. The same law could be shown to obtain with respect to other lines, and the inevitable conclusion is, and indeed has been long acknowledged, that no branches from the main lines pay their expenses. They have proved, almost universally, to be suckers rather than feeders to the main lines. . . ."

French Locomotive Experiences

By EDWARD H. LIVESAY

No. IV—PARIS/HAVRE "AUTORAIL"

(*Continued from page* 250, *August* 15)

MOTOR-PROPELLED railway coaches, "Autorails," as they are termed in France, have been used very extensively there for many years, a practice which has become even more common since the war. They act as "feeders" on cross-country routes connecting with the main lines at important centres, or actually on the main lines, stopping at intermediate points not served by complete steam-powered trains. As a rule, "Autorails" consist of two vehicles (Fig. 11), one motored and the other trailing, but when running over longer routes, such as Paris to Havre they are made up of five vehicles (Fig. 13), the two end ones providing the power, in which case multiple-unit control is employed. The power/weight ratio being high, giving rapid acceleration, average speeds are also high, though the maximum is limited by rules governing all types of traction. It was on one of these five-coach, two-engined "Autorails" running between Paris and Havre, that I concluded my all too short visit to France; it is dealt with in this article. It is the rule, I believe, that one motor-coach pulls one trailer, but when two are powered, three additional vehicles are sandwiched between, which gives a power/weight ratio of 1650 h.p. to 219·5 tons, and explains the rapid acceleration! That power, too, is available at any speed, differing from that provided by a steam locomotive, which has an unfortunate habit of progressively dying away—the faster you go, the less power you have.

Briefly describing the power unit, the outline drawings reproduced as Fig. 12 show the layout of both the motored vehicle and the trailer. The motor is a V-12 supercharged direct-injection diesel, giving 825 h.p. at 1500 r.p.m., with cylinders 175mm by 180mm, the crankshaft revolving anti-clockwise; it is a product of the De Dietrich Company, with the blower by Brown-Boveri, and the cooling of both oil and water is thermostatically controlled. The Maybach transmission is hydro-mechanical through a universally jointed shaft between engine and four-speed gearbox, and thence by fluid coupling and cardan shafts to the axles of the leading bogie; the reduction gear has a ratio of 1·95/1.

Gear changing is automatic, the wheels being always in mesh; gear shaft revolutions and kilometre speeds on the four gears are as follows:—First: 540, 40·5; second: 890, 66·8; third: 1460, 109·7; fourth: 1920, 144·2. Out-of-control safety is ensured by button on the controller and dead man's pedal.

The motor-coach weighs 56 tons in running order, loaded, each driving axle carrying 17·5 tons, giving 35 tons for adhesion; the trailing bogie carries 20 tons. The non-motored coach weighs 36·5 tons, and has a driving compartment for use when the motored vehicle is at the rear. The chassis is tubular, welded to the body; the floor is asbestos insulated, the walls with glass wool, and the interior fittings are plastic. Communication between the two ends is electro-pneumatic, by loudspeaker between guard and driver for starting, acceleration or when it is necessary to pass instructions or information between them, but electrical, directly affecting the motor, for stopping or reversing. Needless to say, a Flaman recorder makes its constant chronicle of everything that happens *en route*.

The electric equipment includes a 72V 12,000W generator running up to 3420 r.p.m., giving full output at 1250 r.p.m., supplying a fifty-four element battery of 300Ah capacity. Current is used for gear changing, lighting, cooling and brake air supply, the pumps for the latter being under the floor. Finally, there are loudspeakers throughout, by which the guard can give information to the passengers.

It was a pity that the journey to Havre had to be made after dark, to connect with the boat to Southampton, which put me as observer at a disadvantage; moreover, there was no interpreter, and as neither mecanicien nor chauffeur spoke English, the physical darkness outside the cab was likely to be accompanied by linguistic obscurity inside. The train, due out of St. Lazare at 7.55 p.m., consisted of five coaches, with the motored units front and rear; it was handsome, very "easy to look at," the upper half of the practically streamlined cars being cream coloured, the lower blue-grey, all the coaches running on four-wheel bogies. Introducing myself to the mecanicien and his aide, I was taken into the driving compartment after a brief look through the passenger part of the vehicle, sundry details being explained to me, some of which took root and bore fruit, but others fell upon stony ground, my French and the mecanicien's English being about on a par—below par, rather. However, the "atmosphere" was just what I always find in French cabs, friendly and companionable, and the confusion of tongues was laughingly waved aside as of no importance—I must not apologise. This was lucky, as I could not do so anyway; but it simplified things; I need merely sit in the comfortable "rout seat," keeping my eyes and ears open, and my mouth shut. And thus we carried on, but now, when it comes to transferring my manifold impressions to paper, I find there is an aftermath; I cannot describe in detail as I would like the exact sequence of operations controlling the train, a difficulty intensified by absence of drawings of the driving mechanism. My apologies are tendered for any vagueness that may be noticed.

Taking our seats in the cab, mine being on the right—I remind the reader that left-hand running is the rule of railroads in France—the motors were started up at 7.50, 5 min ahead of train time, and at 7.57, 2 min late, orders came over the loudspeaker from the guard to pull out. The muffled rumble of the engine in the compartment behind us took on a rising, purposeful note as we got under way, the train accelerating smoothly and very fast under the star-shaped Pont de l'Europe into the Batignolles tunnel just beyond. The hand of the Flaman, right in front of the driver, moved quickly round the dial as second, third and top speeds were shocklessly engaged, each change only perceptible by an alteration in the hum of the motor coupled with a simultaneous forward surge. Through Pont Cardinet station, past the great Batignolles engine shed, where so many of the rebuilt Chapelon "Pacifics" employed on the Havre and Cherbourg services are stabled; flashing through Clichy-Levallois and out over the Seine at Asnières, my *pied a terre* in France, the speed had quickly risen to the full 130km permitted over this route, at which the red hand of the Flaman was set—when red and black hands coincide, shut back, do not exceed!

Fig. 11—Two-coach "Autorail"

The riding was practically perfect; smooth, vibrationless, only an occasional slight lateral sway, and the tilting of the floor on curvature momentarily affecting the prevailing stability of the car. The motion could not well have been better; it was certainly more perfect than that of the pneumatic-tyred coach I sampled on the Strasbourg run (THE ENGINEER, May 28, 1954), and, I think, equalled the riding of the diesel-electric engine sampled between Chicago and Milwaukee seventeen years ago, which I thought at the time, and have continued to think ever

since, was the *ne plus ultra* of locomotion on rails. I compared it in THE ENGINEER to the action of a Rolls-Royce on a perfect road, which was no exaggeration ; incidentally—if I may be allowed to digress for a moment—modern diesel-electrics do not approach that early type in smoothness of riding, if the latest C.P.R. machines are fairly representative of present-day practice, as I think they are, diesel-electric locomotives being practically standardised all over the North American Continent. The explanation probably is that the 1940 machine was built to reach higher speed—117 m.p.h.—than its successors, and far more care was taken of the suspension than is nowadays considered necessary.

Though the "Autorail" had no great headlight of the American pattern, it had two lamps about equal in power to those of the ordinary motor-car, and these, together with two spotlights, lit up the track for several hundred feet ahead, floodlighting it, as it were, the light spreading beyond the sides of the right-of-way. This was comforting, the speed being high ; it had occurred to me there was no cowcatcher, so to be able to see well ahead, with track and lineside bathed in golden radiance engendered a feeling of confidence which I should not have enjoyed had we been sweeping forward into Stygian darkness as in England. In the cab of a steam locomotive one feels that, at any rate, there is most of the engine in front to act as a buffer ; on an "Autorail" there is nothing to take the shock of collision—the cab itself would be the first thing to hit, and you are in it ! I remember feeling the same thing in the cab of the Chicago–Milwaukee machine, running at 110 m.p.h. along unfenced track, and at very high speed through towns with countless level crossings unprotected with gates, and round blind curvature between buildings. It seemed to be tempting Providence, and I said so, the driver concurring, saying, "I don't like this work—this is a young man's job —I am glad to be retiring in a few weeks." In brief, it is best not to think of such things as collisions when one is rushing through the night on an "Autorail" ; take consolation from the thought that the signalling system in France is very good, far better than in Britain, with the result they seldom have collisions on the S.N.C.F.—I nearly put "never," but remembered they had just had one near Avignon.

Asnières, on the north bank of the Seine, 5km from the Gare St. Lazare, is a considerable junction, tracks both "burrowing" and diverging on the level ; we swept through the station at about the 130km limit, with the Rue Henri Barbusse paralleling our line on the right towards Bois-Colombes, an ideal vantage from which to watch through the railings, as I had so often done on "rest days," the fascinating variety of traffic, steam, diesel, electric, double-deck push-and-pull, express, local, freight and light engines returning to Batignolles, streaming by in both directions. I never tired of it—almost could I become a "spotter" ! I looked at it "in reverse" for the few seconds it remained in sight before we swung round the great curve to the left towards suburban Sartrouville, wondering when it would again be my grandstand (next year, D.v.!). The speed remained almost constant at near the limitation, gradients having next to no effect on it, the colour-light signals standing out brilliantly against the blackness of the night, vividly green and red. The profile shows that there are no gradients likely to give any concern to the high-powered "Autorail" until Rouen is approached ; it is largely a "water-level" route, often following along the banks of the Seine, the main road also frequently coming into the picture. It was noticeable that when our headlamps could cause inconvenience to cars moving in the opposite direction, our driver always dimmed his lights, particularly on an "outside" curve, a courtesy showing consideration that I have certainly never seen in N. America, where the powerful headlight throws a beam like a searchlight half-a-mile ahead.

Mantes was passed at 8.30, the floodlit cathedral standing out in silvery beauty ; 58km in 33 min, an average of 63 m.p.h.; Vernon, 8.42, 80km in 47 min, about the same ; the running had been very regular, the red hand of the Flaman, set at 130km, had not often been approached. The smooth, humming flight, the warmth of the cab, the steady gazing ahead at the track flowing towards the engine and disappearing beneath —all these combined to induce sleepiness, and once or twice I nearly succumbed. The enginemen rarely spoke ; there's little to talk about in the cab of an automatic "Autorail." The light was not bright enough for note-making, so I gave it up, after noticing my companions always switched a lamp on when they saw me trying to jot something down ; it resulted in dazzle, and I disliked being responsible for that. Visibility ahead was good, as has been said, the only thing adversely affecting it being the approach to, and passage of tunnels, where vapour from steam-hauled trains entirely blotted it out. There are quite a number of tunnels on this route, eleven if the short Batignolles one is included, three of them in the tricky, serpentine approach to Rouen, which is so complicated by curvature, bridges over the winding Seine, junctions and other varied operational hazards that, looking at it from the cab, one loses one's sense of direction altogether. The Rouen stop, the first, was made at 9.14, 140km in 77 min, an average of 68 m.p.h.; the long, easy non-stop running along the valley of the Seine had made higher speed possible. Two coaches were cut out here, the restart being made at 9.20, leaving two motor-coaches with one idle vehicle sandwiched between. This was typical of the quick station work noticed so often in France ; to detach two of the middle coaches, bring the rest together again and get away in 6 min predicates absence of dawdling.

Leaving Rouen R.D. the train plunges straight into a tunnel at the end of the platform, on a steep up gradient (Fig. 14), another tunnel coming after a very brief gap ; this one was under heavy repair, a permanent speed restriction being in effect, the reminder taking the shape of a flickering electric light on the approach. It is very heavy climbing all the way from Rouen to the top of the great ridge between that city and the Channel Coast, the setting of much of Zola's *La Bête Humaine*, which book was very much in my mind as we passed through the stations and

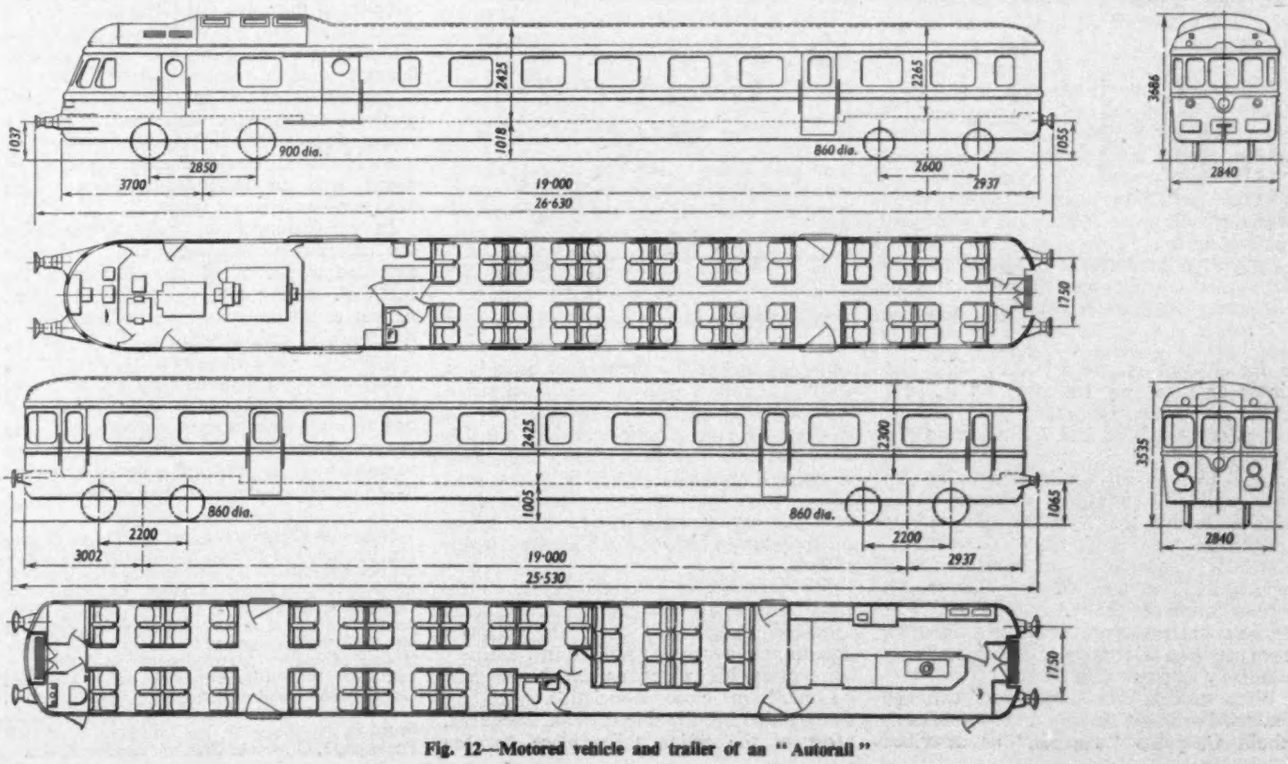


Fig. 12—Motored vehicle and trailer of an "Autorail"

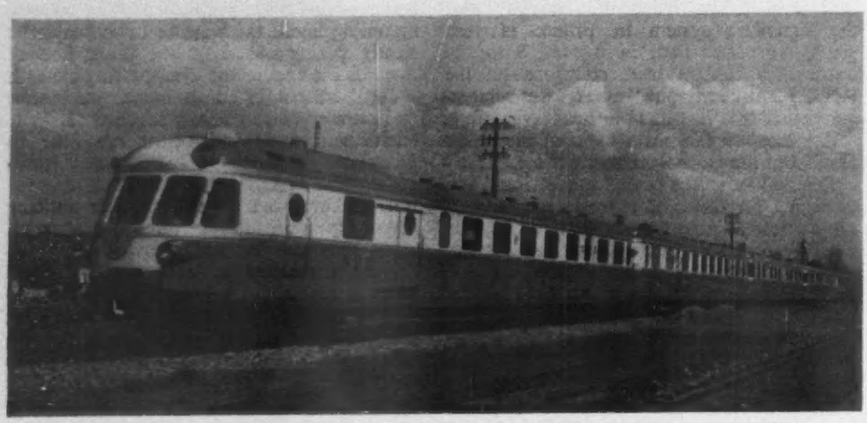


Fig. 13—Five-coach (2 motors) "Autorail"

tunnels figuring so prominently in that gruesome story. Yvetot brought the next stop, 9.45, 35km in 25 min, a 52 m.p.h. average up that very severe incline, good going, indeed. Yvetot climaxes the heavy work, nothing remaining but the crossing of the plateau and the steep descent into Havre, though there was another stop at Beuzeville, 10 p.m. Station names, in black on a white board, showing up very plainly on the approach, set at right angles to the track, must be very useful to drivers, if less so to passengers. The train came to a stand in Havre at 10.14 p.m., having covered the 135 miles from Paris in 137 min, with three stops included, the net running time being 127 min. A very pleasant run, made in the utmost comfort, but it only strengthened my conviction that a steam locomotive, despite its crudity, dirt and discomfort, is to me a lovable beast with a soul, and that a diesel engine has none of these attractions. I cannot conceive of myself becoming fond of a diesel locomotive—"U1," now, a "P," a Stanier "Pacific" or an "A4"—that is another story altogether—you cannot teach an old dog new tricks. Perhaps this does not sound very complimentary either to the "Autorail," which had behaved so well, or in THE ENGINEER, I was puzzled to find the route seemed curiously familiar, though I had never been over it before; I felt as one sometimes does on arrival at a place with which one is consciously unacquainted, but subconsciously familiar—as if one had been there before. The mystery was solved on my return to Canada, a friend, a C.P.R. official, giving me a book he thought might interest me—it was Zola's *La Bête Humaine*, which I then remembered having read when a lad, and since forgotten. It is a railway story, pure and simple—perhaps a better phrase would be impure and complicated, Zola being responsible for it—the scene the line between the Gare St. Lazare and Havre which is portrayed with meticulous accuracy —gradients, stations, junctions, engine sheds, all come into it, much quite unchanged since the story was written in the '90s, based on happenings in 1870. The characters are almost entirely railway people, from directors down through all ranks and ratings to station staffs and enginemen; it is a gruesome tale, most of them coming to a sticky end by murder, accident or suicide, and the less said about their morals the better. It is not a book that paterfamilias should allow his unsophisticated daughter to get hold of—

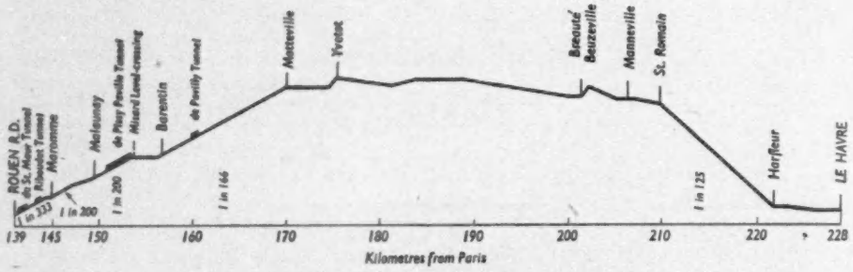


Fig. 14—Profile: Rouen/Le Havre

to the officials of the S.N.C.F., who had kindly arranged my travelling on it, so I hasten to assure everybody that nothing derogatory is implied, nor any reflection cast on either train or personnel; in fact, I am grateful to both for a most interesting run on a technically advanced machine. They will undertand the reactions of a steam locomotive man, and make allowances—Monsieur Chapelon, I am convinced, will sympathise! In fine, there is undoubtedly a great future for the "Autorail," and if its British counterparts prove equally satisfactory there may be a faint hope of British Railways ultimately getting out of the red!

When making runs a couple of years ago between Paris and Havre on the remarkable rebuilt Chapelon "Pacifics," as described supposing that such a thing exists nowadays, which is arguable. But the vivid descriptions of railway life on the Paris–Havre line, the accuracy of most of the technical touches, show that Zola must have made a close study of railway operation and have ridden long distances on the engines, or else he must have had a very well-informed "ghost" as collaborator—which one can hardly imagine of Zola.

The hero, "The Human Beast," Mecanicien Jaques Lantier, has a split and badly deranged personality, and an obsessive urge to kill anyone he loves, so in "escape" he centres his affections on his engine, "Lison," in close association with his disreputable but likeable fireman, Pecqueux. Most of the action takes place between Rouen and Havre, and as the "Autorail" hummed through the darkness over that rugged stretch, the story took on fresh life, and became very real to me. The de Pissy Poville tunnel—in this, Judge Grandmorin was murdered by the Havre assistant station-master Roubaud and his wife, the body being thrown out on to the track near Barentin, to be found by the level-crossing keeper Misard and Lantier, off duty through the breaking of one of "Lison's" connecting-rods. "Lison," with her "great space-devouring wheels," toiling up the long, steep gradient from Harfleur to the peak at Beuzeville, where Lantier fails to get a pilot engine, and struggles on across the wind-swept plateau through Bolbec and Yvetot to Motteville, to be warned of terrible conditions ahead, but carries on, apprehensive of stalling in a drift; "Lison" "setting off wearily down the 8-mile slope to Barentin," and finally beaten to a standstill in a snow-filled cutting near Misard's level-crossing approaching the tunnel—all this and many other line-side details came to mind as the "Autorail" covered the very route, though in the reverse direction.

At the other end of the line, the railway offices coming into the story, in the Rue de Rome and Rue d'Amsterdam, are still in use; I had to visit them just as Lantier, Roubaud—and probably Zola himself—had done. The great Pont de l'Europe, just outside the Gare St. Lazare, from which Zola's characters watched the busy station work on the fan of tracks below, with engines coming from the Batignolles shed; I watched it, too, and it might be described in the same words to-day.

The techniques of engines and their working are very accurate, only an occasional slip being made, and these may be due to the American translation, which jars sometimes —"exhaust pipes" for cylinder cocks; "Lison's" extravagant demands for "grease," where oil is meant, satisfied with the aid of a grease gun (surely grease lubrication was not a practice in 1870, and certainly grease guns were unknown!); a steam pressure of 25 lb—why, even the "Rocket" had 50! Injectors are mentioned, and their working correctly described; there is no criticism of this; was not Giffard's invention dated about the '50s? French enginemen evidently wore goggles even then—sensible fellows. And so on—read *La Bête Humaine* if you are interested in railways and locomotives—steam ones understood. But, I repeat, do not leave it lying about where the unsophisticated could chance upon it—it might lead to misunderstandings. Zola always calls a spade a spade.

In conclusion, I gratefully acknowledge the invariable kindness and assistance extended to me by all the officials of the S.N.C.F. during my visit, without which neither could the runs have been made nor the resulting articles written. In particular, I would mention Messieurs Segaud, Leroy, Leseigneur and Fillon; and last, but not least, Monsieur Chapelon, for information and documents which he subsequently sent. As always, the visit has left very pleasant memories and engendered a desire to repeat it—to which, no doubt, I shall succumb.

SYMPOSIUM ON SHAFT SINKING AND TUNNELLING.—The Institution of Mining Engineers is arranging a three-day symposium on shaft sinking and tunnelling to be held at Olympia, London, on Wednesday, Thursday and Friday, July 15, 16 and 17, 1959, during the period of an exhibition of mining machinery also at Olympia, sponsored by the Council of Underground Machinery Manufacturers. It is expected that papers from a dozen countries will be presented for discussion at the conference. Further details, and forms of application for registration, will be issued in due course by The Institution of Mining Engineers, 3, Grosvenor Crescent, London, S.W.1.

Creep Under Changing Complex Stress Systems

By A. E. JOHNSON, D.Sc., M.Sc.Tech., M.I.Mech.E., J. HENDERSON, B.Sc., and V. MATHUR, B.Sc.

No. III—(*Continued from page* 257, *August* 15)

In previously published work the authors have established on an experimental basis, creep rate-stress-time relations which adequately described the behaviour of a number of engineering materials at practical working temperatures under conditions of complex stress where the complex stress system remained unaltered throughout the course of creep. However, in engineering practice, in general the stress system causing creep may alter during the course of creep, and it is necessary to generalise the creep rate-complex stress-time relations to cover such cases. The present work has determined such generalised relations for a 0·2 *per cent carbon steel at* 450 *deg. Cent., an aluminium alloy RR59 at* 150 *deg. and* 200 *deg. Cent. and a magnesium alloy* (2 *per cent aluminium*) *at* 20 *deg. and* 50 *deg. Cent. The experimental data have also been compared with the predictions of the various mechanical theories of creep, and the likely degree of correctness of these latter assessed.*

General Commentary on the Application of Mechanical Theories to all Materials

COMPARISON of the experimental results with the various mechanical theories has been made on the basis of the value of total creep strain at the end of the various experimental stages. On introducing this matter in earlier paragraphs, it was pointed out that each of the mechanical theories would, in general, predict a differing stage curve form for the general loading tests, and that the deviation of such curve form from that actually existing in the test constituted a portion of whatever cumulative error arose in the comparisons made. In what follows some enlargement on this theme of the stage curve form is given.

In the Appendix the means of computing the stage curve form for the individual mechanical theories is given, and it is obvious that although for each of the theories the elements of the time dependence function for individual stages are intrinsically based upon the creep strain-time relation of the virgin curve form, nevertheless, the actual relation for a given theory will diverge from this form.

A general survey made by the authors in regard to the present materials indicates that this divergence is greatest in the case of the age hardening theory and the strain hardening theory, and least in the case of the superposition theory. The combined strain and age hardening theory shows a divergence akin to that of the age and of the strain hardening theories for low values of n, and a divergence similar to that of the superposition theory for high values of n. Accordingly, it is to be noted that since the experimental results indicated that to a close degree, the original creep time curve of the initial pure tensile stage of each general loading test was repeated to some scale in successive stages of the test, the prediction of the mechanical theories in this matter is incorrect, although in some cases and circumstances the divergence may not be particularly marked.

In further regard to the comparison of experimental results with mechanical theory, already described in detail, it is perhaps possible for the several materials and temperatures concerned in the experiments to learn something further by ascertaining figures corresponding to the general inference of the various theories. This is done in what immediately follows.

The experimental results on the magnesium alloy at 50 deg. Cent. are, however, omitted from these general considerations on account of their relative sparseness.

Age Hardening Theory.—All average error figures are negative, the general average being roughly −40 per cent. The average range of individual errors is virtually 100 per cent.

Strain Hardening Theory.—In the case of the RR59 aluminium alloy, the theory gives a correct average prediction. In other cases the prediction is on the high side, the average figure being +80 per cent. The range of error for all materials is of order of 180 per cent.

Superposition Theory.—The average error figures are negative (with one trivial exception), the general average being −30 per cent. The average range of individual errors is 130 per cent.

Combined Strain and Age Hardening Theory for Chosen Values of n.—The average error of all figures is +25 per cent. The average range of error is 160 per cent. From the above figures it would appear that where a considerable amount of data is available, a lower bound (negative error) to the average error is given by the age and superposition theories generally. An upper bound is given by the strain hardening theory, while the best combined age and strain hardening theory is intermediate, but close to the upper bound, and remote from the lower. In regard to individual errors no theory has an average range of less than 100 per cent. The average range of errors of all theories is 160 per cent.

The above figures suggest that since in the absence of information concerning n it would not be possible to use a combined age and strain hardening theory, an estimate of performance not too far from the truth might be arrived at by taking the average of the predictions of the strain and age hardening theories.

General Commentary on the Application of Modified Prager Equations

As in the case of the mechanical theories, so in that of the modified Prager equations it is useful to summarise the indications of the results as a whole, and see what general implications, if any, arise.

For the materials and temperatures which have been concerned in this work, it is evident that some form of the general equations

$$C_{ij}=[F(J_2)-f(I_2)][S_{ij}]\phi(t)$$

represents creep in the successive stages of the general loading tests, where $f(I_2)$ is independent of the length of stage in the general loading test. In no case does an equation of type

$$C_{ij}=[F(J_2)-f(\alpha_{ij})][S_{ij}]\phi(t)$$

represent the results, except in so far as circumstances arise in which the two equations become identical.

In detail, the following varieties of the equation

$$C_{ij}=[F(J_2)-f(I_2)][S_{ij}]\phi(t)$$

represent the temperatures and materials concerned.

Carbon steel at 450 deg. Cent. :

$$C_{ij}=[F(J_2)-2\cdot12\times10^{-1}(\sqrt{I_2})^{1\cdot36}][S_{ij}]\phi(t).$$

RR59 alloy at 150 deg. Cent. :

$$C_{ij}=[F(J_2)-5\cdot6\times10^{-7}][S_{ij}]\phi(t).$$

RR59 alloy at 200 deg. Cent. :

$$C_{ij}=[F(J_2)-2\cdot5\times10^{-6}][S_{ij}]\phi(t).$$

Magnesium alloy at 20 deg. Cent. :

$$C_{ij}=[F(J_2)-2\cdot3\times10^{-2}(\sqrt{I_2})][S_{ij}]\phi(t).$$

Magnesium alloy at 50 deg. Cent. :

$$C_{ij}=[F(J_2)-4\cdot8\times10^{-6}][S_{ij}]\phi(t).$$

Evidently, therefore, in two instances the $f(\sqrt{I_2})$ is involved in the above equations as a power function of exponent not greatly differing from unity, and the features of the initial term of the Prager equation, compared with the form in the equations of virgin material, are changed in quite closely linear proportion to the invariant value of the integrated creep strain accumulated in previous tests.

In the remaining instances $f(I_2)$ has a stationary value, not zero, and apparently the initial term of the Prager equation changes by a specific amount from the virgin form upon the first increment of general loading, and thereafter apparently remains unchanged, until thermal softening of the material, or the beginnings of creep of a tertiary nature appear. For the RR59 alloy this variety of the equation holds for both temperatures of test. In the case of the magnesium alloy this variety was displayed at the upper temperature of test, while the former type in which $f(I_2)$ linearly depends on integrated $(\sqrt{I_2})$ appears at the lower temperature of test. Since both varieties of equation can occur at suitable temperatures for a given material, the question of the nature of the transition from one form to the other arises and should be an object of future study.

With regard to the physical implications of these results, it is possible that under creep conditions as contrasted with conditions of time independent plastic strain, the initial term of a Prager type equation of the form which has been under consideration, being only a function of stress for the virgin material, will in the case of general loading histories become a function of stress, pre-strain (i.e. accumulated creep strain), and of thermal softening due to the period at temperature.

In the materials exhibiting at suitable temperatures the equations involving $f(I_2)$ as $[\sqrt{I_2}]$ or approximations thereto, the Prager equation initial term is effectively simply a function of stress, and integrated prestrain. In the case where $f(I_2)$ is apparently constant, it appears possible that this term, though modified immediately from the stress dependent term corresponding to virgin material, is virtually dependent upon stress only because the effects of pre-strain are being temporarily balanced by thermal softening.

Some Implications of the Foregoing Results and Analysis

In the previous paragraphs an indication has been given of the likely accuracy of

prediction of the various mechanical theories applied to general loading conditions. The actual means of making such predictions is of course outlined for a tension (T) and torsion (S) system in the Appendix. Any other complex stress system can be reduced to an equivalent tension torsion system by the addition or subtraction of a suitable hydrostatic stress. Thus if σ_1, σ_2, and σ_3, be the principal stresses of a given system, and if σ_3 be subtracted from each, a system arises $(\sigma_1-\sigma_3)$ (positive) 0, $(\sigma_2-\sigma_3)$ (negative) which is of course a tension-torsion system. The equivalent J_2, T, and S, can be computed for this system, and used directly as indicated in the Appendix.

In regard to the modified Prager equations which have been shown in two specific forms to well describe the data of these tests, it is perhaps helpful to indicate how the characteristics of such equations may be arrived at, in a comparatory simple manner, to provide information for prospective designers.

First, it has been shown that the characteristics of the modified Prager equations, which have proved suitable, are independent of period of creep in the various stages of general loading creep. Accordingly, if any exploratory programme be laid down, stages of test of 24 hours only would be quite adequate. Secondly, since tensile creep units only are available to the average person requiring the type of information under consideration, the following remarks refer to a procedure carried out in terms of tensile creep tests of 24 hours duration. Assuming that the material concerned has the same form of virgin creep characteristics as have the materials concerned in this paper (methods for materials differing will be along parallel lines, and should be obvious in given cases), then the virgin material equation

$$C_{ij}=\{AF(J_2)\}[S_{ij}]\phi(t)$$

becomes for pure tension (stress T)

$$Ca=\left\{AF\left(\frac{T^2}{3}\right)\right\}\frac{[2T]}{3}\phi(t).$$

By making a series of twenty-four hours' tensile creep tests under several loads T, the characteristics of the virgin equation may be determined, $F\left(\frac{T^2}{3}\right)$ being directly obtainable from the plot of log tensile stress v. log creep rate at the specific period chosen. If now a stage tensile creep test be made in which the value of T is increased every twenty-four hours, then the characteristics of a suitable general loading equation may be obtained.

If at twenty hours (for example, upon each change of stress) the ratio

$$\frac{\text{Experimental measured axial creep rate}}{\text{axial creep rate computed from virgin material equations}}$$

be evaluated, we have K in the relation for the numerical value of $f(I_2)$, i.e.

$$f(I_2)=A(1-K)F(J_2)$$
$$=A(1-K)F\left(\frac{T^2}{3}\right)$$

for the tensile case.

$f(I_2)$ thus obtained can be plotted against integrated

$$\varepsilon_0=\sqrt{2}\varepsilon a=\frac{2}{\sqrt{3}}\sqrt{I_2}\text{ (for pure tension)}$$

and the form of $f(I_2)$ in the general loading equation

$$C_{ij}=[AP(J_2)-f(I_2)][S_{ij}]\phi(t)$$

may thus be established.

Conclusions

For the materials and temperatures examined in the current investigation the following conclusions may be drawn over the ranges of stress and time concerned.[6]

(1) In general loading tests in which changing complex stress systems of continually increasing stress level are applied to the test piece, the creep curve form for each stage of the test is to some scale very closely that of the composite creep curve of the virgin material.

(2) The facts under (1) above indicate that any expression describing the creep rates arising under general loading conditions may be taken to have the time dependence of the virgin material.

(3) In regard to the prediction of general loading behaviour by means of the so-called mechanical theories of creep, it appears that where such prediction is concerned with a considerable volume of data, the age hardening theory and the superposition theory will predict low values of total creep strain, and the strain hardening theory and the best choice of combined age and strain hardening theory will predict high values, the latter theory of all theories being in general nearest the truth. Unfortunately, it is not possible *an initio* to ascertain which is the best equation form for this theory.

(4)[7] Concerning error in the prediction of the values of isolated total creep strains by the mechanical theories, as contrasted with prediction of considerable data, no mechanical theory appears to have a range of possible error of less than 100 per cent.

(5)[7] It appears that if the average of predictions by the age and strain-hardening theories on the basis of considerable data be taken, this may be quite close to the true value for total creep strains.

(6) None of the mechanical theories predict the creep curve form for individual stages of general loading creep tests which is actually observed in experiment.

(7) In general loading tests on the 0·2 per cent carbon steel at 450 deg. Cent., the creep rate is well represented by a modified Prager creep equation which has the form

$$C_{ij}=\{F(J_2)-f(I_2)\}[S_{ij}]\phi(t)$$

where $F(J_2)$ and $\phi(t)$ refer to virgin material and where

$$f(I_2)=2\cdot12\times10^{-2}[\sqrt{I_2}]^{1\cdot36}.$$

I_2 is the integrated invariant creep strain and equals also

$^2/\sqrt{3}$ (integrated octahedral creep strain).

(8) In the case of the magnesium alloy at 20 deg. Cent., a similar equation well represents the data. In this case, however, $f(I_2)=2\cdot3\times10^{-2}[\sqrt{I_2}]$.

(9) In the case of RR59 alloy at both 150 deg. and 200 deg. Cent. creep rates in the general loading test are well represented by the equation

$$C_{ij}=\{F(J_2)-K\}(S_{ij})\phi(t)$$

where for 150 deg. Cent.

$$K=5\cdot6\times10^{-7}$$

and for 200 deg. Cent.

$$K=2\cdot5\times10^{-6}$$

that is to say, $f(I_2)$ has a stationary value for this material and does not increase with increasing $\sqrt{I_2}$ after the initial stages of general loading.

(10) In the case of the magnesium alloy at 50 deg. Cent., the creep rates are well represented by an equation similar to that which represents the RR59 alloy at 150 deg. and 200 deg. Cent., but in this case K has the value $4\cdot8\times10^{-6}$.

(11) For the materials concerned in these tests complex stress creep behaviour was quite closely isotropic, and anisotropy where occurring was of the relatively simple form, previously met with in simple loading complex stress creep tests on these and similar materials. Any effect of anisotropy on the function $f(I_2)$ was purely arithmetical in nature, of order not greater than 10 per cent, and in most cases considerably less than this.

[6] This consideration is, of course, most important.

[7] The data obtained for magnesium alloy at 50 deg. Cent. are omitted from these considerations.

APPENDIX

Application of the Various Mechanical Theories of Creep to the Estimation of Creep Strains Occurring Under General Loading Conditions

In what follows expressions for unit axial and shear creep strains (as measured in the actual complex stress creep tests) are derived upon the basis of assumption of various mechanical theories of creep. Estimates of creep strain based upon such expressions for the various materials, stresses, and temperatures of the tests, can then be directly compared with the measured axial and shear strains of the creep tests.

Simple Loading Conditions of Complex Stress Creep.—As a result of much experimental work in the past few years, it has been well established that for simple loading conditions of complex stress creep, creep rates may be well represented by equations of the following type.

Equations for the principal creep rates are given by

$$C_1=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][(\sigma_1-\sigma_2)-(\sigma_2-\sigma_1)]\phi(t)$$
$$C_2=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][(\sigma_2-\sigma_3)-(\sigma_1-\sigma_2)]\phi(t)$$
$$C_3=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][(\sigma_3-\sigma_1)-(\sigma_2-\sigma_3)]\phi(t)$$
$$\ldots\ldots\quad(1)$$

Where A_1, A_2, p_1, p_2, are constants, σ_1, σ_2, σ_3, are principal stresses, J_2 is the second stress invariant $=\frac{1}{6}\{\Sigma(\sigma_1-\sigma_2)^2\}$ and $\phi(t)$ is a function of time. For all the materials and temperatures concerned in the current paper, $\phi(t)$ was very closely a simple power function of time over the periods of time concerned in the simple loading creep tests.

Corresponding equations for unit creep rates in directions other than principal directions are given by

$$Cx=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][(\sigma_z-\sigma_y)-(\sigma_z-\sigma_x)]\phi(t)$$
$$Cy=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][(\sigma_y-\sigma_z)-(\sigma_x-\sigma_y)]\phi(t)$$
$$Cz=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][(\sigma_z-\sigma_x)-(\sigma_y-\sigma_z)]\phi(t)$$
$$Cxy=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][\tau xy]\phi(t)$$
$$Cyz=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][\tau yx]\phi(t)$$
$$Czx=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][\tau zx]\phi(t)$$
$$\ldots\ldots\quad(2)$$

Here Cx, Cy, Cz, Cxy, Cyz, Czx, are the unit normal and shear creep rates corresponding to applied normal stresses σ_x, σ_y, σ_z, and shear stresses τxy, τyz, τzx.

For the case made use of in the experimental work, i.e. an applied single tensile T, and single shear stress S, the last group of equations become

Axial creep rate

$$Ca=Cx=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][2T]\phi(t)$$
$$Cy=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][-T]\phi(t)$$
$$Cz=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][-T]\phi(t)$$

Shear creep rate

$$Cc=Cxy=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][S]\phi(t)$$
$$Cyz=0$$
$$Cxz=0$$
$$\ldots\ldots\quad(3)$$

Ca and *Cc* being the rates measured in the experimental work.

For simple loading conditions in which anisotropy arises the principal creep rate equations (1) become

$$C_1=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]\times[\alpha_1(\sigma_1-\sigma_2)-\alpha_2(\sigma_3-\sigma_1)]\phi(t)$$
$$C_2=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]\times[\alpha_2(\sigma_2-\sigma_3)-\alpha_1(\sigma_1-\sigma_2)]\phi(t)$$
$$C_3=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]\times[\alpha_3(\sigma_3-\sigma_1)-\alpha_2(\sigma_2-\sigma_3)]\phi(t)$$
. . . . . (4)

where J_2 now=

$$\tfrac{1}{6}\Sigma\{\alpha_1^2(\sigma_1-\sigma_2)^2\}.$$

The equations for unit creep rates in directions other than principal directions become

$$Cx=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]\times[\alpha_1(\sigma_x-\sigma_y)-\alpha_2(\sigma_z-\sigma_x)]\phi(t)$$
$$Cy=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]\times[\alpha_2(\sigma_y-\sigma_z)-\alpha_1(\sigma_z-\sigma_y)]\phi(t)$$
$$Cz=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]\times[\alpha_3(\sigma_z-\sigma_x)-\alpha_2(\sigma_y-\sigma_z)]\phi(t)$$
$$Cxy=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][\alpha_4\tau_{xy}]\phi(t)$$
$$Cyz=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][\alpha_5\tau_{yz}]\phi(t)$$
$$Czx=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][\alpha_6\tau_{zx}]\phi(t)$$
. . . . . (5)

where α_1, α_2 α_3, α_4, α_5, and α_6 are anisotropy constants.

For the case of a single applied tensile stress T, and shear stress S, equations (5) become

$$Ca=Cx=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][T][\alpha_1+\alpha_3]\phi(t)$$
$$Cy=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][T][-\alpha_1]\phi(t)$$
$$Cz=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][T][-\alpha_3]\phi(t)$$
$$Cc=Cxy=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][S][\alpha_4]\phi(t)$$
$$Cxy=0$$
$$Czx=0$$
. . . . . (6)

Ca and *Cc* being again the rates measured in the experimental work.

For the case of pure torsion, from geometrical considerations $C_1=Cc\sin\alpha\cos\alpha$ where α is the angle between principal axes and the axis of the specimen, α of course =45 deg.

Accordingly,

$$C_1=\frac{Cc}{2}$$

and since

$$\sigma_1=-\sigma_2=S$$

we have

$$C_1=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][2\alpha_1+\alpha_3][S]\phi(t)$$
$$=\frac{Cc}{2}=[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][\alpha_4][S]\phi(t)$$

or

$$\alpha_4=\frac{[2\alpha_1+\alpha_3]}{3}.$$

Accordingly, the equations for *Ca* and *Cc* in (6) become

$$Ca=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][\alpha_1+\alpha_3]T\phi(t)$$
$$\text{and } Cc=\tfrac{3}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][2\alpha_1+\alpha_3]S\phi(t)$$
. . . . . (7)

In the tests concerned in the paper the materials either behave virtually isotropically, or exhibit some slight anisotropy of one particular variety. In this kind of anisotropy $\alpha_1=\alpha_3=1$, and accordingly the measured creep rates *Ca*, and *Cc* of the experimental work become as follows.

With $\alpha_1=\alpha_3=1$

$$Ca=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][2T]\phi(t)$$
$$=\tfrac{3}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][T]\phi(t)$$
$$\text{and } Cc=\tfrac{3}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][3S]\phi(t)$$
$$=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][S]\phi(t)$$
$$C_y=C_z=-\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}][T]\phi(t).$$

These creep rates are precisely the same as in the case of isotropy except that

$$J_2=\tfrac{1}{6}\{(\sigma_1-\sigma_2)^2+\alpha_2^2(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2\}$$

instead of the isotropic value

$$J_2=\tfrac{1}{6}\{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2\}.$$

The alteration arising in *Ca* and *Cc* due to the above factor is usually relatively small. The type of anisotropy in question arises when a certain optimum degree of plastic creep strain in a specific direction has taken place in the material. For relatively small strains an initial state of isotropy is preserved.

General Loading Conditions of Complex Stress Creep.—In what follows the simple loading complex stress creep equations are applied by use of various mechanical theories to the prediction of creep strains under general loading conditions, the assumption being made that the simple loading equation has validity over the time range concerned in the general loading tests.

In view of the fact that the general form of the unit axial and shear creep rate equation for the cases of isotropic strain and anisotropic strain have already been outlined, and since the experimental work was expressly framed to avoid the incidence of anisotropy so far as possible, the following argument is expressed in terms of the isotropic forms only of the equations for *Ca* and *Cc*.

$$Ca=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]T\phi(t)$$
$$\text{and } Cc=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]S\phi(t)$$
. . . . . (8)

The commonly known "mechanical theories" of creep are the age hardening theory, the strain hardening theory, the combined strain and age hardening theory, and an extension or rather generalisation of the Volterra or Boltzmann superposition theory. The equations (8) as they stand are susceptible of multiple solutions, the three forms of which are consistent with the age hardening, strain hardening, and combined strain and age hardening theories.

In the case of superposition theory the equations are used virtually as a vehicle to apply the principle of superposition.

Age Hardening Theory.—The age hardening theory states in effect that the creep rate is a function only of the current stress system, and the time at temperature, however the current stress system has been reached.

The equations

$$Ca=\tfrac{1}{2}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]T\phi(t)$$
$$Cc=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]S\phi(t)$$
. . . . . (8)

are obviously therefore directly in a form to express the age hardening theory for complex stress conditions.

For general loading conditions suppose that the stress system after the initial loading at $t=0$, be changed at t_1, t_2, t_3, --- tN. During the periods 0 to t_1, t_1 to t_2, t_2 to t_3 --- to tN, let the corresponding stress functions be J_{2_1} --- J_{2_N}, T_1 --- T_N, S_1 --- S_N.

Integrating the equations (8) between limits $t=0$ to $t=t_1$ we obtain

$$\varepsilon a_1=\tfrac{1}{2}[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}][T_1]t_1^m$$
$$\varepsilon c_1=2[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}][S_1]t_1^m$$
. . . . . (9)

where t^m is the integral of $\phi(t)$. Again integrating the same equations from $t=t_1$ to $t=t_2$ we obtain

$$\varepsilon_{a_2}-\varepsilon_{a_1}=\tfrac{1}{2}[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}][T_2][t_2^m-t_1^m]$$
$$\varepsilon_{c_2}-\varepsilon_{c_1}=2[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}][S_2][t_2^m-t_1^m]$$
. . . . . (10)

By similar integrations

$$\varepsilon_{a_3}-\varepsilon_{a_2}=\tfrac{1}{2}[A_1(J_{2_3})^{p_1}+A_2(J_{2_3})^{p_2}][T_3][t_3^m-t_2^m]$$
$$\varepsilon_{c_3}-\varepsilon_{c_2}=2[A_1(J_{2_3})^{p_1}+A_2(J_{2_3})^{p_2}][S_2][t_3^m-t_2^m]$$
. . . . . (11)

&c., and ultimately

$$\varepsilon_{a_N}-\varepsilon_{a_{N-1}}=\tfrac{1}{2}\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\times\left[T_N\right]\left[t_N^m-t_{N-1}^m\right]$$
$$\varepsilon_{c_N}-\varepsilon_{c_{N-1}}=2\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\times\left[S_N\right]\left[t_N^m-t_{N-1}^m\right]$$
. . . . . (12)

Now let

$$t_2^m=K_2t_1^m$$
$$t_3^m=K_3t_2^m$$
- - - -
- - - -
$$\text{up to } t_N^m=K_Nt_{N-1}^m.$$

Then the above equations may be rewritten

$$\varepsilon_{a_2}-\varepsilon_{a_1}=\tfrac{1}{2}[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}][T_2][t_1^m][K_2-1]$$
$$\varepsilon_{c_2}-\varepsilon_{c_1}=2[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}][S_2][t_1^m][K_2-1]$$
. . . . . (11)

$$\varepsilon_{a_3}-\varepsilon_{a_2}=\tfrac{1}{2}[A_1(J_{2_3})^{p_1}+A_2(J_{2_3})^{p_2}]\times[T_3][t_1^m][K_3-1][K_2]$$
$$\varepsilon_{c_3}-\varepsilon_{c_2}=2[A_1(J_{2_3})^{p_1}+A_2(J_{2_3})^{p_2}]\times[S_3][t_1^m][K_3-1][K_2]$$
. . . . . (12)

&c., and ultimately

$$\varepsilon_{a_N}-\varepsilon_{a_{N-1}}=\tfrac{1}{2}\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\left[T_N\right]\times\left[t_1^m\right]\left[K_N-1\right]\left[K_{N-1}\right]\text{ - - - }\left[K_2\right]\left[K_2\right]$$
$$\varepsilon_{c_N}-\varepsilon_{c_{N-1}}=2\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\left[S_N\right]\times\left[t_1^m\right]\left[K_N-1\right]\left[K_{N-1}\right]\text{ - - - }\left[K_2\right]\left[K_2\right]$$
. . . . . (12)

Obviously, therefore, the pairs of values ε_{a_1} and ε_{c_1} - - - - ε_{a_N}, ε_{c_N}, may be evaluated by simply adding the equations (9), (10), (11), &c., up to (12), up to the time concerned.

Thus by addition of (9) and (10)

$$\varepsilon_{a_2}=\tfrac{1}{2}t_1^m\{[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}][T_2][K_2-1]+[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}][T_1]\}$$
$$\varepsilon_{c_2}=2t_1^m\{[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}][S_2][K_2-1]+[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}][S_1]\}$$

By addition of (9) (10) and (11)

$$\varepsilon_{a_3}=\tfrac{1}{2}t_1^m\{[A_1(J_{2_3})^{p_1}+A_2(J_{2_3})^{p_2}][T_3][K_3-1][K_2]+[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}][T_2][K_2-1]+[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}][T_1]$$
$$\varepsilon_{c_3}=2t_1^m\{[A_1(J_{2_3})^{p_1}+A_2(J_{2_3})^{p_2}][S_3][K_3-1][K_2]+[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}][S_2][K_2-1]+[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}][S_1]\}$$

&c., and ultimately

$$\varepsilon_{a_N}=\tfrac{2}{3}t_1^m\left[\sum_2^N\left\{\left[\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\left[T_N\right]\times\left[K_N-1\right]\left[K_{N-1}\right]\cdots\left[K_3\right]\left[K_2\right]\right\}+\left[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right]\left[T_1\right]\right]$$

and

$$\varepsilon_{c_N}=2t_1^m\left[\sum_2^N\left\{\left[\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\left[S_N\right]\times\left[K_N-1\right]\left[K_{N-1}\right]\cdots\left[K_3\right]\left[K_2\right]\right\}+\left[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right]\left[S_1\right]\right]$$

Thus the unit creep strains ε_{a_N} and ε_{c_N} are uniquely determined for the general loading test at the end of any stage occurring at time t_N, and may be compared with values determined by experiment.

If the course of the creep strain time curve over the stage t_{N-1} to t_N be required, the functions

$$\left[\varepsilon_{a_{N-1+x}}-\varepsilon_{a_{N-1}}\right],\text{ and }\left[\varepsilon_{c_{N-1+x}}-\varepsilon_{c_{N-1}}\right]$$

are simply evaluated for a series of values of x corresponding to values of t between t_{N-1} and t_N.

Thus

$$\left[\varepsilon_{a_{N-1+x}}-\varepsilon_{a_{N-1}}\right]=\tfrac{2}{3}\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\left[T_N\right]\left[t^m_{N-1+x}-t^m_{N-1}\right]$$

and

$$\left[\varepsilon_{c_{N-1+x}}-\varepsilon_{c_{N-1}}\right]=2\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\left[S_N\right]\left[t^m_{N-1+x}-t^m_{N-1}\right]$$

Generalised Superposition Theory.—With the same convention regarding the addition of stresses at various periods of time, generalised superposition theory supposes the total creep to be equal to the sum of the elements of creep due to the added elements of stress, which in the present terminology would correspond to the sum of creep strains respectively due to stress functions T_1, S_1, J_2, for time 0 to time t_N, (i.e. the whole of the time), due to stress functions (T_2-T_1), (S_2-S_1), $(J_{2_2}-J_{2_1})$, for time t_1 to t_N : and ultimately due to stress functions (T_N-T_{N-1}), (S_N-S_{N-1}), and $J_{2_N}-J_{2_{N-1}})$ for time t_{N-1} to t_N.

With the same nomenclature as before we obviously have

$$\varepsilon_{a_N}=\tfrac{2}{3}\left[\left[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right]\left[T_1\right]t^m_N+\left[A_1(J_{2_2}-J_{2_1})^{p_1}+A_2(J_{2_2}-J_{2_1})^{p_2}\right]\times\left[T_2-T_1\right]\left[t_N-t_1\right]^m+\cdots\left[A_1(J_{2_N}-J_{2_{N-1}})^{p_1}+A_2(J_{2_N}-J_{2_{N-1}})^{p_2}\right]\left[T_N-T_{N-1}\right]\left[t_N-t_{N-1}\right]^m\right]$$

$$\varepsilon_{c_N}=2\left[\left[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right]\left[S_1\right]t^m_N+\left[A_1(J_{2_2}-J_{2_1})^{p_1}+A_2(J_{2_2}-J_{2_1})^{p_2}\right]\times\left[S_2-S_1\right]\left[t_N-t_1\right]^m+\cdots\left[A_1(J_{2_N}-J_{2_{N-1}})^{p_1}+A_2(J_{2_N}-J_{2_{N-1}})^{p_2}\right]\left[S_N-S_{N-1}\right]\left[t_N-t_{N-1}\right]^m\right]$$

The values ε_{a_N}, ε_{c_N}, may be used as for the previous theory to check the predictions of the theory against experimental values of creep strain at the end of the various stages of the general loading complex stress creep tests.

To trace the course of the creep strain time curve over the stage t_{N-1} to t_N, the functions

$$\left[\varepsilon_{a_{N-1+x}}-\varepsilon_{a_{N-1}}\right],\text{ and }\left[\varepsilon_{c_{N-1+x}}-\varepsilon_{c_{N-1}}\right]$$

are evaluated for a series of values of x corresponding to values of t between t_{N-1} and t_N, making use of the relations

$$\left[\varepsilon_{a_{N-1+x}}-\varepsilon_{a_{N-1}}\right]=\tfrac{2}{3}\left[\left\{A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right\}\left[T_1\right]t^m_{N-1+x}+\left\{A_1(J_{2_2}-J_{2_1})^{p_1}+A_2(J_{2_2}-J_{2_1})^{p_2}\right\}\times\left[T_2-T_1\right]\left[t_{N-1+x}-t_1\right]^m+\cdots+\left\{A_1(J_{2_N}-J_{2_{N-1}})^{p_1}+A_2(J_{2_N}-J_{2_{N-1}})^{p_2}\right\}\times\left[T_N-T_{N-1}\right]\left[t_{N-1+x}-t_{N-1}\right]^m\right]$$

$$-\tfrac{2}{3}\left[\left\{A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right\}\left[T_1\right]t^m_{N-1}+\left\{A_1(J_{2_2}-J_{2_1})^{p_1}+A_2(J_{2_2}-J_{2_1})^{p_2}\right\}\times\left[T_2-T_1\right]\left[t_{N-1}-t_1\right]^m+\cdots+\left\{A_1(J_{2_{N-1}}-J_{2_{N-2}})^{p_1}+A_2(J_{2_{N-1}}-J_{2_{N-2}})^{p_2}\right\}\times\left[T_{N-1}-T_{N-2}\right]\left[t_{N-1}-t_{N-2}\right]^m\right]$$

and

$$\left[\varepsilon_{c_{N-1+x}}-\varepsilon_{c_{N-1}}\right]=2\left[\left\{A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right\}\left[S_1\right]t^m_{N-1+x}+\left\{A_1(J_{2_2}-J_{2_1})^{p_1}+A_2(J_{2_2}-J_{2_1})^{p_2}\right\}\times\left[S_2-S_1\right]\left[t_{N-1+x}-t_1\right]^m+\cdots+\left\{A_1(J_{2_N}-J_{2_{N-1}})^{p_1}+A_2(J_{2_N}-J_{2_{N-1}})^{p_2}\right\}\times\left[S_N-S_{N-1}\right]\left[t_{N-1+x}-t_{N-1}\right]^m\right]$$

$$-2\left[\left\{A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right\}\left[S_1\right]t^m_{N-1}+\left\{A_1(J_{2_2}-J_{2_1})^{p_1}+A_2(J_{2_2}-J_{2_1})^{p_2}\right\}\times\left[S_2-S_1\right]\left[t_{N-1}-t_1\right]^m+\cdots+\left\{A_1(J_{2_{N-1}}-J_{2_{N-2}})^{p_1}+A_2(J_{2_{N-1}}-J_{2_{N-2}})^{p_2}\right\}\times\left[S_{N-1}-S_{N-2}\right]\left[t_{N-1}-t_{N-2}\right]^m\right]$$

Strain Hardening Theory.—This theory postulates that the creep rate at a specific period is a function only of the current stress system, and the creep strain at that time, and does not depend upon the path by which the current stress system has been reached.

Consider the integrated form of the simple loading creep equations

$$\varepsilon_a=\tfrac{2}{3}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]T\,.\,t^m$$

$$\varepsilon_c=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]S\,.\,t^m.$$

Then by transformation

$$[\varepsilon_a]1/m=\{\tfrac{2}{3}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]T\}^{1/m}\,.\,t$$

$$[\varepsilon_c]1/m=\{2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]S\}^{1/m}\,.\,t.$$

Differentiating both sides w.r.t. time

$$1/m\left[\varepsilon_a\right]^{\overline{1/m-1}}Ca=\left\{\tfrac{2}{3}\left[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}\right]T\right\}^{1/m}$$

$$1/m\left[\varepsilon_c\right]^{\overline{1/m-1}}Cc=\left\{2\left[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}\right]S\right\}^{1/m}$$

By rearrangement

$$Ca=\frac{m\left\{\tfrac{2}{3}\left[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}\right]T\right\}^{1/m}}{\left[\varepsilon_a\right]^{\overline{1/m-1}}}$$

$$Cc=\frac{m\left\{2\left[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}\right]S\right\}^{1/m}}{\left[\varepsilon_c\right]^{\overline{1/m-1}}}$$

. . . . . (12)

Equations (12) are the general strain hardening equations. Integrating these equations between limits of time $t=0$, to $t=t_1$

$$\left[\varepsilon_{a_1}\right]^{1/m}=\left\{\tfrac{2}{3}\left[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right]\left[T_1\right]\right\}^{1/m}t_1$$

$$\left[\varepsilon_{c_1}\right]^{1/m}=\left\{2\left[A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\right]\left[S_1\right]\right\}^{1/m}t_1$$

. . . . . (13)

Between limits of time $t=t_1$, and $t=t_2$

$$\left[\varepsilon_{a_2}^{1/m}-\varepsilon_{a_1}^{1/m}\right]=\left\{\tfrac{2}{3}\left[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}\right]\left[T_2\right]\right\}^{1/m}\left[t_2-t_1\right]$$

$$\left[\varepsilon_{c_2}^{1/m}-\varepsilon_{c_1}^{1/m}\right]=\left\{2\left[A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}\right]\left[S_2\right]\right\}^{1/m}\left[t_2-t_1\right]$$

. . . . . (14)

&c., and ultimately between limits of time $t=t_{N-1}$ to $t=t_N$

$$\left[\varepsilon_{a_N}^{1/m}-\varepsilon_{a_{N-1}}^{1/m}\right]=\left\{\tfrac{2}{3}\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\left[T_N\right]\right\}^{1/m}\left[t_N-t_{N-1}\right]$$

$$\left[\varepsilon_{c_N}^{1/m}-\varepsilon_{c_{N-1}}^{1/m}\right]=\left\{2\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\left[S_N\right]\right\}^{1/m}\left[t_N-t_{N-1}\right]$$

. . . . . (15)

Obviously pairs of values $\varepsilon_{a_1}^{1/m}$, $\varepsilon_{c_1}^{1/m}$, $\cdots\varepsilon_{a_N}^{1/m}$, $\varepsilon_{c_N}^{1/m}$ may be evaluated by adding the equations (13), (14) $\cdots$ (15) up to the time concerned, just as the values ε_{a_1}, ε_{c_1}, $\cdots\varepsilon_{a_N}$, ε_{c_N}, were obtained in the case of the age hardening theory.

Accordingly, in general terms

$$\varepsilon_{a_N}^{1/m}=\left[\sum_1^N\left\{\tfrac{2}{3}\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\times\left[T_N\right]\right\}^{1/m}\left[t_N-t_{N-1}\right]\right]$$

$$\varepsilon_{c_N}^{1/m}=\left[\sum_1^N\left\{2\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\times\left[S_N\right]\right\}^{1/m}\left[t_N-t_{N-1}\right]\right]$$

The values of the total creep strains at the ends of the various stages, may be obtained by raising the above expression to the power m. Thus

$$\varepsilon_{a_N}=\left[\sum_1^N\left\{\tfrac{2}{3}\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\times\left[T_N\right]\right\}^{1/m}\left[t_N-t_{\overline{N-1}}\right]\right]^m$$

$$\varepsilon_{c_N}=\left[\sum_1^N\left\{2\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]\times\left[S_N\right]\right\}^{1/m}\left[t_N-t_{\overline{N-1}}\right]\right]^m$$

The above values correspond to the end of stages at time t_N, and may be compound with values determined by experiment.

To trace the course of the creep strain time curve over the stage $t_{\overline{N-1}}$ to t_N, the functions

$$\left[\varepsilon_{a_{\overline{N-1+x}}}-\varepsilon_{a_{\overline{N-1}}}\right],\text{ and }\left[\varepsilon_{c_{\overline{N-1+x}}}-\varepsilon_{c_{\overline{N-1}}}\right]$$

are evaluated for a series of values of x corresponding to values of t between $t_{\overline{N-1}}$ and t_N, making use of the relations

$$\left[\varepsilon_{a_{\overline{N-1+x}}}-\varepsilon_{a_{\overline{N-1}}}\right]=\left\{\sum_1^N\left[\tfrac{2}{3}\left\{A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right\}\right]^{1/m}\times\left[T_N\right]^{1/m}\left[t_{\overline{N-1+x}}-t_{\overline{N-1}}\right]\right\}^m-\left\{\sum_1^{\overline{N-1}}\left[\tfrac{2}{3}\left\{A_1(J_{2_{\overline{N-1}}})^{p_1}+A_2(J_{2_{\overline{N-1}}})^{p_2}\right\}\right]^{1/m}\times\left[T_{\overline{N-1}}\right]^{1/m}\left[t_{\overline{N-1}}-t_{\overline{N-2}}\right]\right\}^m$$

and

$$\left[\varepsilon_{c_{\overline{N-1+x}}}-\varepsilon_{c_{\overline{N-1}}}\right]=\left\{\sum_1^N\left[2\left\{A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right\}\right]^{1/m}\times\left[S_N\right]^{1/m}\left[t_{\overline{N-1+x}}-t_{\overline{N-1}}\right]\right\}^m-\left\{\sum_1^{\overline{N-1}}\left[2\left\{A_1(J_{2_{\overline{N-1}}})^{p_1}+A_2(J_{2_{\overline{N-1}}})^{p_2}\right\}\right]^{1/m}\times\left[S_{\overline{N-1}}\right]^{1/m}\left[t_{\overline{N-1}}-t_{\overline{N-2}}\right]\right\}^m$$

Combined Strain and Age Hardening Theory.—Consider the integrated form of the simple loading creep equations

$$\varepsilon_a=\tfrac{2}{3}[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]Tt^m$$
$$\varepsilon_c=2[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]St^m$$

Raise both sides of the equations to the nth power

$$\varepsilon_a{}^n=\{(\tfrac{2}{3})^n[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]^n[T]^nt^{nm}\}$$
$$\varepsilon_c{}^n=\{(2)^n[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]^n[S]^nt^{nm}\}.$$

Differentiate w.r.t. time

$$\frac{d\varepsilon_a{}^n}{d\varepsilon_a}\frac{d\varepsilon_a}{dt}=\left\{(\tfrac{2}{3})^n[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]^n[T]^nnmt^{\overline{nm-1}}\right\}$$

$$\frac{d\varepsilon_c{}^n}{d\varepsilon_c}\frac{d\varepsilon_c}{dt}=\left\{(2)^n[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]^n[S]^nnmt^{\overline{nm-1}}\right\}$$

which last equations become

$$n\varepsilon_a{}^{n-1}\frac{d\varepsilon_a}{dt}=\left\{(\tfrac{2}{3})^n[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]^n[T]^nnmt^{\overline{nm-1}}\right\}$$

$$n\varepsilon_c{}^{n-1}\frac{d\varepsilon_c}{dt}=\left\{(2)^n[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]^n[S]^nnmt^{\overline{nm-1}}\right\}$$

on transposing

$$Ca=\frac{d\varepsilon_a}{dt}=\frac{m\left\{(\tfrac{2}{3})^n[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]^n[T]^nt^{\overline{nm-1}}\right\}}{\varepsilon_a{}^{\overline{n-1}}}$$

$$Cc=\frac{d\varepsilon_c}{dt}=\frac{m\left\{(2)^n[A_1(J_2)^{p_1}+A_2(J_2)^{p_2}]^n[S]^nt^{\overline{nm-1}}\right\}}{\varepsilon_c{}^{\overline{n-1}}}$$

. . . . . (17)

Equations (17) are the general combined age and strain hardening equations for the type of simple loading equation in question, and represent the creep rate at a specific period, as a function of the time, the creep strain, and the current stress system at that period independently of how the current stress system has been reached. Integrating equation (17) between limits of time $t=0$, $t=t_1$ we obtain

$$\varepsilon_{a_1}{}^n=[\tfrac{2}{3}]^n\{A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\}^n[T_1]^nt_1{}^{nm}$$
$$\varepsilon_{c_1}{}^n=[2]^n\{A_1(J_{2_1})^{p_1}+A_2(J_{2_1})^{p_2}\}^n[S_1]^nt_1{}^{nm}$$

. . . . . (18)

Integrating between limits $t=t_1$, and $t=t_2$

$$[\varepsilon_{a_2}{}^n-\varepsilon_{a_1}{}^n]=[\tfrac{2}{3}]^n\{A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}\}^n[T_2]^n[t_2{}^{nm}-t_1{}^{nm}]$$
$$[\varepsilon_{c_2}{}^n-\varepsilon_{c_1}{}^n]=[2]^n\{A_1(J_{2_2})^{p_1}+A_2(J_{2_2})^{p_2}\}^n[S_2]^n[t_2{}^{nm}-t_1{}^{nm}]$$

. . . . . (19)

and ultimately between limits t_N and $t_{\overline{N-1}}$

$$\left[\varepsilon_{a_N}{}^n-\varepsilon_{a_{\overline{N-1}}}{}^n\right]=\left[\tfrac{2}{3}\right]^n\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]^n\left[T_N\right]^n\left[t_N{}^{nm}-t_{\overline{N-1}}{}^{nm}\right]$$

$$\left[\varepsilon_{c_N}{}^n-\varepsilon_{c_{\overline{N-1}}}{}^n\right]=\left[2\right]^n\left[A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right]^n\left[S_N\right]^n\left[t_N{}^{nm}-t_{\overline{N-1}}{}^{nm}\right]$$

. . . . . (20)

Obviously pairs of values $\varepsilon_{a_1}{}^n$, $\varepsilon_{c_1}{}^n$, - - - $\varepsilon_{a_N}{}^n$, $\varepsilon_{c_N}{}^n$, may be evaluated by adding the equations (18), (19), - - - (21) up to the time concerned following the procedure used in the case of the age hardening and strain hardening theories.

Thus in general we have

$$\varepsilon_{a_N}{}^n=(\tfrac{2}{3})^n\left[\sum_1^N\left\{A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right\}^n\times\left[T_N\right]^n\left[t_N{}^{nm}-t_{\overline{N-1}}{}^{nm}\right]\right]$$

$$\varepsilon_{c_N}{}^n=(2)^n\left[\sum_1^N\left\{A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right\}^n\times\left[S_N\right]^n\left[t_N{}^{nm}-t_{\overline{N-1}}{}^{nm}\right]\right]$$

where finally

$$\varepsilon_{a_N}=\tfrac{2}{3}\left[\sum_1^N\left\{A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right\}^n\times\left[T_N\right]^n\left[t_N{}^{nm}-t_{\overline{N-1}}{}^{nm}\right]\right]^{1/n}$$

$$\varepsilon_{c_N}=2\left[\sum_1^N\left\{A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right\}^n\times\left[S_N\right]^n\left[t_N{}^{nm}-t_{\overline{N-1}}{}^{nm}\right]\right]^{1/n}$$

which gives the total strains at the various stages of time t_N, &c.

To trace the course of the creep strain time curve over the stage $t_{\overline{N-1}}$ to t_N, the functions

$$\left[\varepsilon_{a_{\overline{N-1+x}}}-\varepsilon_{a_{\overline{N-1}}}\right],\text{ and }\left[\varepsilon_{c_{\overline{N-1+x}}}-\varepsilon_{c_{\overline{N-1}}}\right]$$

are evaluated for a series of values of x corresponding to values of t between $t_{\overline{N-1}}$ and t_N.

$$\left[\varepsilon_{a_{\overline{N-1+x}}}-\varepsilon_{a_{\overline{N-1}}}\right]=\tfrac{2}{3}\left[\sum_1^N\left\{A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right\}^n\times\left[T_N\right]^n\left[t_{\overline{N-1+x}}{}^{nm}-t_{\overline{N-1}}{}^{nm}\right]\right]^{1/n}-\tfrac{2}{3}\left[\sum_1^{N-1}\left\{A_1(J_{2_{\overline{N-1}}})^{p_1}+A_2(J_{2_{\overline{N-1}}})^{p_2}\right\}^n\times\left[T_{\overline{N-1}}\right]^n\left[t_{\overline{N-1}}{}^{nm}-t_{\overline{N-2}}{}^{nm}\right]\right]^{1/n}$$

and

$$\left[\varepsilon_{c_{\overline{N-1+x}}}-\varepsilon_{c_{\overline{N-1}}}\right]=2\left[\sum_1^N\left\{A_1(J_{2_N})^{p_1}+A_2(J_{2_N})^{p_2}\right\}\times\left[S_N\right]^n\left[t_{\overline{N-1+x}}{}^{nm}-t_{\overline{N-1}}{}^{nm}\right]\right]^{1/n}-2\left[\sum_1^{N-1}\left\{A_1(J_{2_{\overline{N-1}}})^{p_1}+A_2(J_{2_{\overline{N-1}}})^{p_2}\right\}^n\times\left[S_{\overline{N-1}}\right]^n\left[t_{\overline{N-1}}{}^{nm}-t_{\overline{N-2}}{}^{nm}\right]\right]^{1/n}$$

Visual Landing Aid

AN optical system which will provide the pilots of aircraft with information about their course in the vertical plane, in much the same manner as an i.l.s. glide path indicator, has been developed by R.A.E., Farnborough, and installed at Blackbushe Airport. It will also be installed at Aberdeen, Prestwick, Belfast and Liverpool.

The device, known as the Visual Glide Path Indicator, consists of two sets of lights about 500ft apart along the runway near its touchdown area, each set comprising a light each side of the runway. Each light has a beam of which the bottom half is red and the top half white: the division between red and white is in each case set parallel to the i.l.s. glide path. Thus, a pilot on the prescribed path sees the nearer lights white and the further red, but if he is too low or too high all the lights are red or white. The nearer red will be visible until the aircraft is down to about 500ft if the aircraft remains in the prescribed path.

The light sources in the lanterns are glass-envelope sealed light units, such as are usually associated with United States practice, specially made by A.E.I. They are focused upon a slit, and the upper part of the converging beam is passed through a red filter. It is expected that these lanterns will be free from the defective indications sometimes given by the three-colour approach lights, attributed to condensation of moisture on lenses. All the lamps are wired in series, so that there is no possibility of one part of the display disappearing and the remainder being deceptive. Variation in brilliance between night and day conditions is achieved by control of supply voltage.

Experiments with a Vortex Furnace

By WING-COMMANDER T. R. CAVE-BROWNE-CAVE, C.B.E., F.R.Ae.S., M.I.Mech.E.

This article describes work done in 1954–55 for the development of a vortex furnace in which comparatively large particles of fuel were stuck to the molten surface of a bowl of slag and burnt with air passing over them at high relative air speed. The primary object of the development was to use coal of high ash content in such a way that the ash did not seriously interfere with combustion. The ash content of the fuel remained as molten slag, building up on the surface of the bowl until it drained away through a central hole. It was carbon-free slag, which is a valuable product. Air introduced through a gallery with high circumferential speed formed a free vortex sweeping over the fuel held stationary on the intensely hot surface of the bowl. The great relative speed made possible rates of heat release far in excess of normal practice. This may be the more important achievement for wider application. The work was done by John Thompson Water Tube Boilers, Ltd., in a furnace devised by the author. It was initially encouraged by the Ministry of Fuel and Power and by the National Coal Board.

IN order to achieve a very high rate of heat release from solid fuel, it is desirable that the air with which it is to burn should have great velocity relative to the solid fuel. This is necessary in order to maintain a rapid supply of oxygen and also to sweep away the products of combustion which would otherwise separate the fuel from the oxygen essential for its combustion. In a pulverised fuel furnace the particles of fuel are too small to maintain any considerable speed relative to the air which surrounds them. As each particle burns it quickly becomes enveloped in a cloud of the products of its own combustion and is screened from the oxygen it needs. In a conventional p.f. furnace the small particles of fuel burn to still smaller particles of ash which are very difficult to remove from the boiler or from the gases liberated to the atmosphere. Even when caught, they are costly to dispose of.

Vortex Furnace

The vortex furnace here described is shown in half-section on the left of the illustration. It has a cylindrical wall and a conical floor which when covered with slag merge into a bowl, with a central downward slag outlet with a water seal. The products of combustion pass upwards through a central throat and would pass into the boiler. Coal which passed ¼in mesh was fed into an air trunk from a blower and passed into the furnace by the circumferential fuel gallery which tapered in depth 12in to zero and had a circumferential slot of uniform 1½in width. The amount of primary air was only sufficient to carry the fuel. Secondary air (with no preheating) was introduced by a larger concentric taper duct further from the wall of the furnace. This arrangement had the effect of driving the particles of fuel on to the wall of the furnace, where they rolled round and down, driven by the circumferential velocity of the air, till they reached a zone covered with slag hot enough to cause them to stick to it.

The great relative velocity of the air tearing over the stationary fuel made it burn rapidly. The ash content of the fuel remained sticking to the bowl, where it formed the hot adhesive to ignite and hold succeeding particles of fuel. As the slag thickness on the bowl increased, the escape of heat through it decreased and the surface temperature became such that the surface slag would flow down to a central slag outlet. It was in the form of fused slag, which is valuable. It was not "dust and ashes," the disposal of which is costly. The air entering the furnace had a circumferential speed in the air gallery of some 175ft per second. In the absence of combustion, it would form a free vortex ($v \times r$=constant), of which the characteristic is that the speeds of rotation near the axis become extremely high and the relative speed of adjacent layers is also great. The influence of combustion on this theoretical regime would be difficult to determine, but at high temperature the viscosity of the gas is so great that the relative speed between adjacent layers will be greatly reduced and the system will differ from that of a free vortex tending more towards the forced vortex (v/r=constant) in which there is little relative speed between adjacent layers. It seems clear, however, that in the vortex which is formed there will be extreme turbulence, mixing the air with the burning gas and helping combustion to be completed in a comparatively small space. The furnace was lit up by a torch of oily waste introduced below the fuel duct.

Operation in Practice

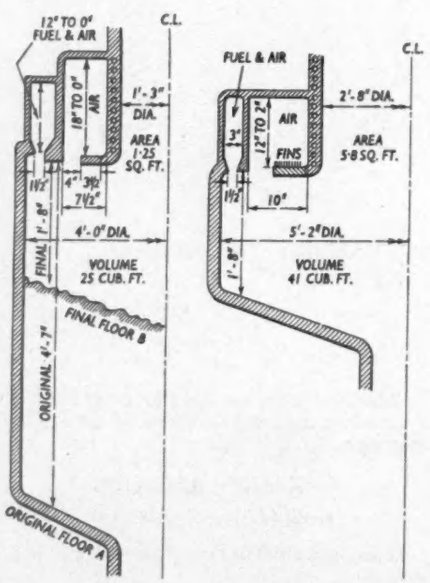
In this first arrangement, although the fine dust and the volatiles ignited easily, most of the larger particles actually fell through the hot zone which they formed and remained almost unburnt on the floor of the furnace. The furnace was far too deep. The defect was not at first realised because a large chimney mounted over the outlet prevented a clear view down into the furnace when working: it also made it extremely difficult to get into the furnace for careful examination when cold. There was a wide gap round the mouth of the furnace and, therefore, the chimney did not make any important contribution to the flow through the furnace. Its removal did not alter the conditions in the furnace, but made it much easier for observers to see what was happening. When the furnace was run without the chimney, the whole action was clearly seen. The furnace was then filled up to within about 2ft of its crown, with the same fuel as used for the tests. This raised the floor from *A* to *B*, Fig. 1. It then lit up easily and warmed up quickly, but particles of fuel were blown off the bottom surface before an adhesive slag bed was formed. Some glass was thrown into the furnace to start slagging. The slag bed then built up satisfactorily and the process worked exactly as desired without the addition of more glass.

The coal used for the tests acquired, during a long period of winter weather, a large and variable quantity of moisture. This resulted first in erratic action of the fuel feeders and, even when this had been corrected, the very fine dust caked at various points in the long duct which led to the fuel gallery of the furnace. This prevented long runs under steady conditions.

When the date by which the work had to be stopped was near at hand, it was decided to run the furnace at its greatest capacity for a final period in order that the final examination of the furnace when stripped should show whether the desired regime had been established. At the end of the trials, the rate of fuel supply was accurately checked. A section of the duct under the feeder was removed and the rate of delivery was accurately measured, with the feeder continuing to run at the same speed and setting as during the last trial. With this arrangement, coal having an ash content of 26 per cent and a calorific value of 10,000 B.Th.U.s per pound was burnt for a short period at the rate of 2·25 tons per hour in the furnace, having a combustion volume of 25 cubic feet. The combustion was smokeless, but considerable visible flame at the outlet showed that combustion was not fully completed inside the furnace. The calculated rate of heat release must be somewhat reduced on that account, but without that deduction the rate is 2,400,000 B.Th.U.s per cubic foot per hour, which is much greater than that achieved even in large oil-fired boilers.

A very bright pool of slag formed in the bottom of the furnace. A film of molten slag formed on the surface of the gas outlet throat and drops were blown off its upper lip. While the furnace was running, so far as could be seen through the throat and through a hole which was made in the refractory of the roof when the furnace was shut down, the cylindrical wall of the furnace was much cooler than the bottom, which was covered with a pool of intensely bright molten slag.

Examination of the furnace when cold showed that the dimensions of the combustion space were as shown in Fig. 1. The cylindrical wall was covered with a glaze about ¼in thick over the refractory lining. The floor was covered with a pool of slag 2·5in to 3in thick, to the top surface of which particles of partly burnt coal were stuck exactly as intended. Analysis of the slag at mean thickness of this layer showed carbon



Figs. 1 and 2—As constructed, the furnace was cylindrical with a conical floor between 4ft and 5ft below the air and fuel trunks, as shown on the left. Experience showed that a less deep furnace, as proposed on the right, would be preferable

content nil, and the drops blown from the lip of the throat had 0·006 per cent. The edges of the fuel and the air galleries were undamaged. The lower corner of the throat was burnt, although the throat was water cooled. This is not surprising because if the exit temperature of the gas was 1800 deg. Cent. as it appeared, and if the 2·25 tons of fuel per hour was burning with 9 lb of air per pound of coal, the gas speed through the throat must have been some 900ft per second axially, with rapid rotation.

The final trial, although of only short duration, was very promising because it showed the definite formation of a pool of slag which could have been drained away through a water seal. The rate of heat release was extremely high, presumably because the particles of fuel were stuck to the slag bed and burnt in air passing over them at very high speed.

Suggested Further Development

From this point it now seems reasonable to design a furnace (Fig. 2), with much the same form of fuel and air galleries, but of larger diameter in order to give a wider throat and greater volume. The height of the cylindrical wall should be about the same as on the final test, because it is on the floor of the furnace, not on the vertical walls, that the combustion of the non-volatiles takes place and the slag bed is formed. The fuel should be fixed on to this slag bed as promptly as possible, in order to avoid dust being caught up by turbulence in the air stream.

Fig. 2 shows such a furnace in comparison with Fig. 1, which shows the furnace of the final test. The volume has been increased from 25 cubic feet to 41 cubic feet, and the throat area from 1·25 square feet to 5·8 square feet. If the maximum output of furnace "A" is taken as 2 tons per hour, the new furnace "B" should work continuously at, say, 3 tons per hour. The gas speed in the throat would be reduced from 900ft per second to 290ft per second. The rotational speed in the air gallery would be increased from 195ft to 260ft per second. The shape of the air duct has been altered and its bottom formed as a steel plate, finned on the upper side so as to give more heat to the combustion air and make up for the absence of an air preheater.

Conclusion

The furnace in its altered form (Fig. 1) acted exactly as intended and as theory explains. Its essential feature is that the fuel is held stationary on an incandescent bed, while the air passes over it at very high relative speed. This resulted in the following advantages :—

(1) It attained a remarkably high rate of heat release.

(2) The ash content of the coal appeared almost wholly as fused slag, deposited on the floor of the furnace where it does not interfere with combustion and whence it can no doubt be drained through a water seal. The slag was carbon-free and valuable. There was little, if any, fly ash or "dust and ashes," the disposal of which is costly.

(3) A combustion chamber of this design seems likely to provide a means of burning coal which would otherwise be useless on account of high ash content.

The combustion of fuel stuck to a surface and swept by a vortex with great relative air speed may have wide application in various connections.

Another Car Ferry—M.V. "Compiegne"

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

ATTENTION has recently been drawn to the phenomenal increase in the number of cars carried between this country and Belgium, via Dover and Ostend, necessitating the building of the car ferry M.V. "Artevelde," already described in this journal.* A similar state of affairs took place regarding the carriage of cars from this country to France, for whereas in 1938, 50,000 cars were accounted for, the number for 1955 was 198,000, and by 1957 it had risen to 231,000, a number which is likely to be considerably exceeded in the current year.

The history of the car ferry service of our railways on their short sea passages begins in the year 1931, when the Southern Railway brought into service a vessel built for the special purpose of competing with a private company which had initiated a service between Dover and Calais. "Autocarrier" (Fig. 1) was really but an ordinary cargo steamer, incorporating no special features, while shore facilities were crude and cars had to be handled by crane. About thirty-five cars could be carried. The leading dimensions of "Autocarrier" were: length, 220·3ft; breadth, 35·6ft; depth, 14·1ft; tonnage, 822 gross. She was driven by two sets of triple-expansion engines, with cylinders having diameters of 15in, 25in and two of 29in, with a stroke of 21in.

The next step forward occurred when, in 1946–47, the relatively large passenger steamer "Dinard" was converted by Palmer's Hebburn Company, Ltd., into a car ferry. She had been delivered by her builders, William Denny and Brothers, Ltd., in 1924 to the Southern Railway for their passenger service between Southampton and St. Malo. Her principal dimensions were: length, 316ft; breadth, 41·1ft; depth, 13·9ft; tonnage, 2294 gross. She was driven by four single-reduction geared turbines. As reconstructed, she could accommodate from seventy to eighty cars, and 300 passengers.

Admittedly, "Dinard" was a definite advance on "Autocarrier," but it soon became obvious that further tonnage was necessary, and in the light of experience gained a turbine steamer was designed and built, on and off which cars could readily be driven directly by means of suitable ramps at both ends. "Lord Warden" entered the service in 1952, and although she has been fully described in these pages,† it might be well to repeat for comparison purposes her chief dimensions, these being: length, overall, 361·5ft, between perpendiculars, 338ft; breadth moulded, 59ft, at waterline, 51ft; depth to main deck, 51ft; tonnage, 3333 gross; speed, 20 knots; cars carried, 120; passengers, 1000.

During the period just reviewed the train ferry had been evolved and put into operation by three turbine steamers built for the Southern Railway, and as all services between England and France were sponsored by both British and French railways, one vessel, "Twickenham Ferry," flew the French flag. When a new vessel was required, French Railways (S.N.C.F.) brought into service the M.V. "Saint Germain."‡ A similar position has now been reached regarding the car ferries, and French Railways rightly felt that it was now their turn to contribute a vessel, with a result that an order was placed with the Société des Chantier Réunis "Loire-Normandie" to build the first vessel of the type to be constructed in France. "Compiegne" (Fig. 2) was built in their Grand-Quevilly shipyard at Rouen, under the supervision of the Bureau Veritas.

The new vessel embodies a number of interesting features and can accommodate 164 cars on the Dover–Calais route, and will also be able to operate in the winter months between Dover and Boulogne. Her principal dimensions are as follows: length, overall, 377ft, between perpendiculars, 358ft; maximum overall width (with fenders), 60ft 4in; depth, to promenade deck, 34ft 5in; mean draught, 13ft 1in; deadweight, 641 tons; tonnage, 3400 gross. On her trials she attained a speed of over 21

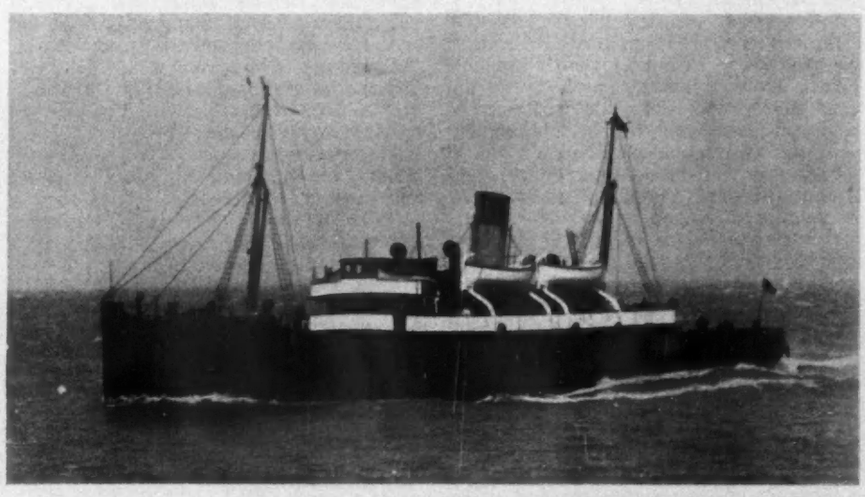


Fig. 1—S.S. "Autocarrier" entering Dover harbour

* The Engineer, July 18, 1958, page 98.

† The Engineer, June 27, 1952, page 854.

‡ The Engineer, September 14, 1951, page 331.

Fig. 2—French car ferry "Compiegne" for the Calais-Dover service

knots, and 20 knots is reckoned to be her service speed.

"Compiegne" is the first vessel in the narrow seas to have three car decks; all cars are driven on to the main deck aft, and access to the upper decks, which are located forward, is by means of interior ramps. Each of the upper decks has a height of 7ft 4½in, while that of the lower deck is 12ft 6in high, thereby enabling it to accommodate the largest motor coaches. Special attention has been given to the ventilation of the car decks, the exhaust gases being drawn off by air suction pumps and fresh air blown in.

The embarkation door was designed and constructed by the Société MacGregor-Comarain and is composed of two jointed panels, folding upwards to a horizontal position. A hydraulic jack in the interior of the panels controls the opening and shutting. Hydraulic power controls the locking of the doors in both open and closed positions. The hydraulic circuit has been so designed that the unbolting from one position, the opening or closing, and the bolting of the door in the other position, can be effected in succession from a single control point. Oil is supplied under pressure by an electro-hydraulic unit situated near the door; the output of the engine is 10 h.p., while the constant discharge rate of the pump is 14 litres per minute.

In a vessel of this type it is essential that every step should be taken to ensure the most complete safety precautions against fire, and French Railways claim that theirs are the most complete to be installed so far on a passenger vessel and the first to comply with the Convention of London's No. 1 specification for precautions against fire. Among the many precautions taken it may be mentioned that on the car decks metal fire-proof curtains can shut off three sections one from the other, while rows of powerful water sprinklers afford additional fire barriers and numerous foam hydrants can be operated instantaneously. In the passenger accommodation the floors, ceilings and walls are all made of fireproof materials

Provision has been made for carrying 1000 passengers, of one class only, and the accommodation is excellent. On the promenade deck is found a spacious lounge with bar, two wide promenades, and a comfortable and spacious dining saloon which can seat 132; on the boat deck is another lounge with large windows which afford a good view over the bows of the vessel, and there is also a snack bar. A sun deck is also available for use on daylight passages if and when the weather permits. It might be mentioned that extensive use has been made of materials such as Formica, aluminium, &c., all designed to give an impression of light and space; at the same time the decoration generally is simple, and in line with modern taste. The lifeboats are made of a special British fireproof plastic, which is also shock-absorbing to a considerable degree.

As regards the propulsion of the vessel a number of very interesting features are noticed. She is driven by two V-16-cylinder supercharged diesel engines, which have been built by the Société Générale de Constructions Mécaniques at La Courneuve, under licence from the Société des Etudes de Moteurs Thermiques. Each engine is rated at 4500 h.p. at 345 r.p.m., and drives direct on to the propeller shaft, the propellers being of the "Kamewa" reversible type; they can be controlled direct from the bridge as regards pitch, while the speed of the vessel can be varied by the captain without reference to the engine-room staff. Electric power is provided by three Gramme 280kVA alternators, delivering 50 cycle three-phase current at 380V, these alternators being driven by engines built by the Société Générale de Constructions Mécaniques. It is claimed that the system of current distribution applied provides complete protection against untoward incidents.

Like most cross-Channel vessels "Compiegne" is equipped with both stern and bow rudders, and has a separate gear aft for steering when proceeding astern in port. In addition a novel feature has been incorporated in that transverse manœuvring tunnels have been fitted near the bows under the waterline with the necessary propellers which render it possible to exert a transverse thrust to port or starboard, thereby greatly facilitating the handling of the vessel when casting off or coming alongside, and avoiding the necessity of enlisting the services of a tug.

"Compiegne" is provided with all the modern aids to navigation, and would appear to be eminently suited to her work; as seen by the particulars given she is rather larger than "Lord Warden," her only drawback being the vibration which seems inseparable from the diesel vessel as compared with the smooth running of the modern turbine steamer.

Some time back the Eastern Region of British Railways as an experiment put on a train specially to carry cars, their drivers and passengers from King's Cross to Perth, thus giving a "flying" start to a holiday in Scotland. The idea soon found favour, and now French Railways are adopting the same idea and running a "car sleeper express" from Boulogne to Lyons, cars and passengers being conveyed on the same train.

Railbuses on British Railways

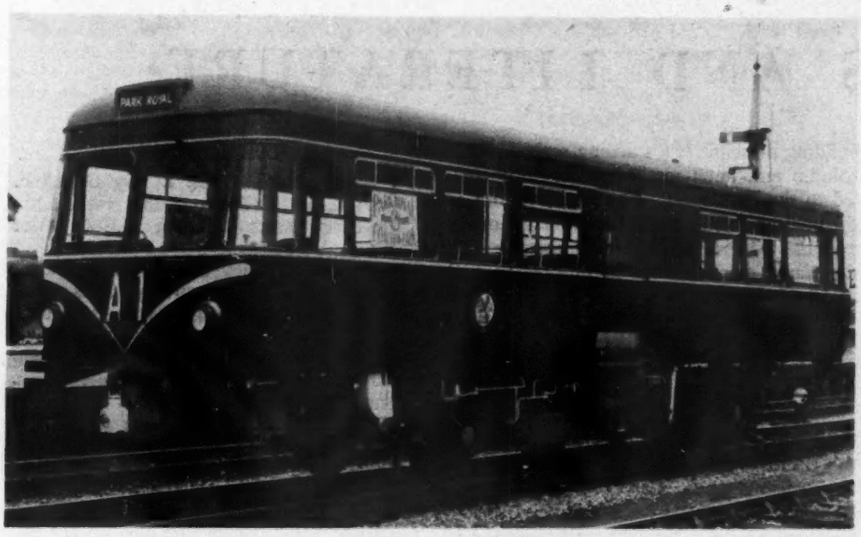
Particulars have been issued of two different makes of the railbuses being built for British Railways and now going into service. General notes on these vehicles are given below with details of some of their more interesting points in design.

DIESEL railbuses ordered by British Railways are now being placed in service, and particulars have been received of the first vehicle delivered by Park Royal Vehicles, Ltd., and two of those built jointly by Bristol Commercial Vehicles and Eastern Coach Works, Ltd. The railbuses being supplied by Park Royal Vehicles, Ltd., one of which is illustrated opposite, are for services between Bedford and Northampton, in one direction, and Hitchin, in the other. They have a 43ft 4in long body, which provides seats for fifty passengers and sufficient standing room for another fifty.

Each of the Park Royal vehicles is fitted with a B.U.T. 150 b.h.p., six-cylinder, under-floor-mounted horizontal oil engine. The transmission equipment, supplied by Self-Changing Gears, Ltd., is similar to that used in B.R. multiple-unit stock and comprises 20in fluid coupling, freewheel unit, four-speed direct air-operated epicyclic gearbox, and an axle-mounted reversing final drive geared for a maximum speed of 60 m.p.h. Driver's controls are provided at each end of the car. Each vehicle is built as two substantially separate parts—the power underframe and the body—and the suspension has been designed under a B.U.T. licence.

With the form of springing used special double-row spherical roller bearing axleboxes do not embody horn guides, but are located entirely by the side bearing spring. The box has safety guide lugs working in conjunction with guide plates on the underframe in the event of spring failure. The side bearing springs are longer and have a lower rate than is ordinarily used on railway stock, and they have a solid buckle shrunk on and secured by wedges over the spring leaf centre locating dimples. The buckle is clamped below the axlebox by a separate cap secured by four high-tensile studs and nuts, and is located in box and cap by pegs. The spring is anchored by an eccentric pin at one end, the other end bearing against a case-hardened guide and wearing plate to allow spring movement on deflection. This layout provides positive location of the axle and box while allowing a soft ride to be obtained by the elimination of all but interleaf friction within the spring assembly.

The body framing is based on a welded steel channel section body underframe which,



150 b.h.p. railbus by Park Royal Vehicles, Ltd.

combined with a stressed body sides and roof structure, results in a self-supporting box structure of the necessary rigidity. On this structure are mounted four triangulated suspension brackets, positioned to clear the four outer corners of the main power underframe, and having their thrust faces set at 45 deg. to the underframe top face. Located on these faces by two dowels are the top reaction and location plates of the main suspension coil springs, the bottom ends of which are located in similar plates carried on threaded eye bolts, passing through the spring and body bracket and located in trunnion blocks mounted to the power frame. The vertical body movement on loading is transferred to angular compression of the springs and as the load increases the spring angle more nearly approaches the vertical, thus varying the spring rate to suit increasing load. Free vertical oscillation is damped by four telescopic hydraulic shock absorbers mounted between body and power frame, and lateral and longitudinal movement is prevented by four "Ferobestos"-faced brackets on the power frame registering inside corresponding box members in the body, clearance being left in the static position. These body stops come into use on braking or acceleration and on sudden changes of direction such as points, crossovers, &c., and also enable the vehicle to be towed in the event of breakdown.

The railbuses built by Bristol Commercial Vehicles, Ltd., and Eastern Coach Works, Ltd., have an unladen weight of 13½ tons, and their general construction is based on an integral design with an all-steel underframing and an aluminium body. These vehicles have an underfloor Gardner 112 b.h.p. oil engine designed to provide a maximum speed of 50 to 55 m.p.h. The transmission equipment, also supplied by Self-Changing Gears, Ltd., includes an 18in fluid flywheel, and a five-speed gearbox arranged for automatic gear selection and engagement.

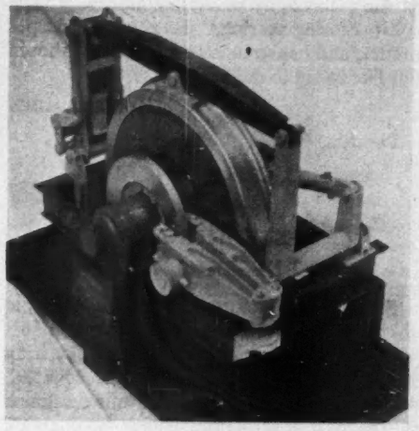
The vehicles have a single driving axle which carries the double-reduction final drive unit. The axle is generally similar to that of a heavy lorry, except that it has no differential. There are two spiral bevels for forward and reverse, which are engaged by dogs operating from air cylinders, and interlocking prevents movement of the vehicle until the dogs are correctly engaged. A manually operated neutral position is provided to allow the vehicle to be towed should it be necessary. The wheels fitted to the vehicle are of the Svenska Aktibolaget Bromsregulator (Sweden) resilient type. In these wheels the rims are flexibly mounted relative to the centres by a system of rubber "bobbins," which serve to reduce wheel shock and noise when travelling.

The suspension of these railbuses is effected by "Metalastik" rubber units in two stages. Each axle is attached to a subframe through two pairs of "Chevron" rubber sandwiches, while the main structure is supported from the subframes by eight rubber spring units, four at each subframe. In side elevation the axes of the spring units make an angle of 15 deg. with the horizontal and load is taken by the rubber in compression and shear. Damping is by separate vertical and horizontal telescopic hydraulic gear, and brake torque reaction links are fitted at both axles.

Interior of railbus built jointly by Bristol Commercial Vehicles, Ltd., and Eastern Coach Works, Ltd.

The vehicles are fitted with a new braking system developed by the Dunlop Company and known as the "monitor brake system," with disc brakes. The photograph we reproduce of a demonstration model clearly shows the operating principle of this new system. In it a beam carrying a monitor shoe is pivoted on two vertical links which, in turn, pivot about their mounting brackets. An air operating cylinder is fitted in one vertical link: when it brings the monitor shoe into contact with the wheel rim, it causes the vertical links and beam to swing in the direction of wheel rotation.

An arm extending from the second vertical link energises a hydraulic double-acting master cylinder. This master cylinder supplies fluid under pressure to a caliper operating cylinder which forces the friction pads into contact with the disc.



Model showing layout of the Dunlop monitor braking system

Air supply to the brake operating cylinder is controlled manually by a lever on the driver's desk. Each brake is independent, although all brakes are applied together. Hydraulic fluid is supplied from two tanks, each tank having separate compartments for each brake.

Oil level in each tank is shown by a sight tube. The vents for air cylinder and caliper cylinder are piped through transparent plastic hoses to points above possible flood water level, and the vent pipe extremities are fitted with filters. If necessary, the brakes can be mechanically operated by means of a hand brake lever in each driver's cab.

Pad clearances with brakes off are automatically maintained at a constant amount and no adjustment is necessary. The pads are changed when fully worn by removal of a split pin and nut, allowing the carrier plate to be withdrawn. The caliper arms are then opened by the tool provided and the new pads secured in position.

MINING TRANSFORMERS.—The Metropolitan-Vickers Electrical Company, Ltd., has introduced a range of nitrogen-filled sealed pattern mining transformers with Class H insulation, for use underground in coal mines. The units are specially designed for convenience of installation underground, and are lighter than conventional oil-filled transformers. They are contained in robust weld-sealed tanks, which are easily cleaned, and are fitted with specially developed metal-seal bushings. A flameproof pattern neutral link and fuse chamber provided permits either single fusing to N.C.B. Specifications P.108 and P.109, or double fusing and phase-to-phase excitation of the injection coil. The transformers are three-phase and have a standard voltage ratio of 3,300/565V at no-load, with high voltage tappings for −5 per cent and −10 per cent brought to links in a flameproof oil-filled chamber on the tank end.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"THE SPIRIT OF ENGINEERING"

SIR,—My old friend and colleague Charles Osborne misquotes me in his letter in THE ENGINEER of August 8. I defined technology as the philosophy of craftsmanship. "The spirit of engineering" is a much deeper matter, and has so many aspects that I should not like to try to define it.

HUGH CLAUSEN

London, N.W.2,

August 13, 1958.

ÆSTHETICS AND ENGINEERING DESIGN

SIR,—Three factors prompt me to write this letter. First, Hugh Clausen in his lecture to the Institution of Engineering Designers, published in your issue June 20, 1958, highlights a possible serious weakness in the design structure of our engineering industry, which if left untreated would be beyond repair by Governments or financial bodies. Also Clausen's brilliant analysis of the depreciation of design values creeping into the industry leaves no shadow of doubt that the blind spot exists at the highest intellectual level and that there is a need to study, find or resurrect an æsthetic of engineering. There must be one for the simple reason that the engineer is a man who makes and thereby creates an object to perform a function. He, therefore, cannot escape from the influence of the æsthetic ethos of the period in which he lives. Waterloo bridge and Charing Cross railway bridge over the Thames are adequate examples of æsthetic influence separate from the technological development.

Secondly, Charles Osborne in his letter, "The Spirit of Engineering," published in your August 8, 1958 issue carries the case for æsthetics and engineering a stage further and I must say he handles the arts with confidence and convincing skill. Osborne establishes a basic factor applicable to all forms of creation, that is the form order of present-day advanced thinking is four dimensional. The three-dimensional order of form became inadequate and philosophically untrue between 1925 and 1930. This change affecting man and his environment has taken place and the major problem confronting advanced thinking is one of communication. There is no easy answer to this difficult problem.

Thirdly, the quality of imagination is an essential part of any æsthetic principle guiding original thinking of the period. I received a notable shock with this element during my recent visit to the Russian Pavilion at the Brussels International Exhibition. In this pavilion there are two medium-sized scale models, one of an automatic tunnel boring and walling machine and a railway crane for building sumultaneously three parallel prefabricated viaducts. The viaduct building principle is a startling revival of the column and lintel method which ultimately led to the Parthenon. The later addition of the arch and vault made the Roman Empire possible. It is reasonable to assume that these two creations are in production and thereby indicating the Russian ability to give rein to an imagination comparable to that of the boy up to the age of about twelve years and to state in no uncertain terms the speed and scale with which this country is developing its means of communication. Imagination of this quality is hardly likely to see daylight in this country while finance and sales dominate the decisions on the boards of directors. It is, however, just conceivable that the Government might help, providing the ideas were sold to them on any basis other than the quality of imagination.

I am not an engineer, but an art critic observing strictly from outside. My interest in this subject, however, arises from a four-year association with engineers of various categories which has given me an opportunity to observe their ways and methods of thinking. The engineer creates metal structures to produce, harness or aid power. His creations fall between the two major arts of sculpture and architecture and he has little or no understanding of either. Sculpture is the art of space displacement and architecture is the art of space enclosure. The engineer can only be said to be successful in these terms when the environment is so dominant that the form order is inherent within the element, hence above and below the ocean, airborne, or down under the earth's crust. In these environments and their machines are the richest source of the unwritten research for laws of engineering æsthetics. Above ground he naturally feels fancy free and familiar with his own environment. His imagination is, however, dissipated and his form is usually of a very crude elementary order. This weakness does not surprise me, because I find through conversation with the engineer that his knowledge of the third dimension is not developed beyond the rudimentary intellectual euclidean perception, which is consistent with his drawing-board training and its particular state of mind. He misses out on the third. The command of the third dimension out of which arises architecture and sculpture as such, is much more apparent in the work of the advanced civil engineer.

There is, therefore, a case for research, a need to overcome the problems of communication between science, engineering and the arts, and a gap to be filled by our universities in the training of future engineers. It is also reasonable to assume that this has been done in Russia, regardless of the fact that their arts are arrested at the eighteenth and nineteenth centuries as a political issue. This state, however, does not prevent them from studying the Western development of the Arts.

ALBERT GARRETT

London, W.1.

August 11, 1958.

Book Reviews

Network Synthesis. Vol. I. By DAVID F. TUTTLE, Jnr. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 188s.

THIS is the first volume of a two-volume work on the principles of network synthesis and it deals exclusively with the synthesis of two-terminal networks. Volume II will be devoted to four-terminal networks. The synthesis is for prescribed characteristics, when operating in a steady a.c. state and the time-domain synthesis is not considered. The book opens with two short chapters in which network analysis is briefly reviewed. This is followed in Chapter 3 by a lucid introduction to the theory of a complex variable, and in particular those aspects are thoroughly discussed which find application in the subsequent treatment. The inclusion of this chapter is valuable for it makes reference to other books unnecessary.

Chapter 4 is devoted to the important concept of "positive reality" of the network functions and various tests for this property are given in Chapter 5. The realisation of networks with two kinds of elements is then treated. The conventional synthesis of L-C networks leading to the equivalent Foster and Cauer representation is given in Chapter 6 and the four canonical representations of the R-L and R-C networks in Chapter 7. Chapter 8 is concerned with the relationship which exists between the real and imaginary parts of the driving point functions and the concepts of minimum reactance and minimum resistance and their duals are established. It is shown how the driving point function can be computed from a knowledge of one part only, and in this connection the methods of Brune-Gewertz and of Bode are discussed. The synthesis of R-L-C networks is taken up in Chapter 9 along the classical lines suggested by Brune and the extension due to Darlington is given, whilst the realisation of this type of network without the use of mutual inductances, as was found simultaneously by Bott and Duffin and by Darlington is discussed in Chapter 10.

This concludes the realisation part of the synthesis of two-terminal networks and the next chapter contains a few specific applications of two-terminal networks. This is followed in Chapter 12 by a discussion of the effects of parasitic dissipation, inductance and capacitance of practical network elements and their effect on network realisation. Having dealt in considerable detail with the properties and the realisation of two-terminal networks, the important topic of approximation is taken up in Chapter 13. After describing the method of trial and error, the least-mean-square error of approximation is discussed, and this is followed by a detailed treatment of the Taylor approximation leading to the mathematically elegant technique due to Padé. The use of Padé's table, which forms a convenient summary of the Taylor approximation, is illustrated. The Chebyshev approximation is dealt with next and the chapter concludes with a short discussion of weighted approximations.

The approximation problem by the use of potential theory analogy is treated in Chapter 14, which is a long chapter of over 100 pages. Starting from a simple two-dimensional electrostatic field distribution, the analogy between complex variable theory and two-dimensional potentials is developed in

some detail and more complicated mapping problems are discussed. This part forms an extension of the subject matter of Chapter 3 on complex variable theory. The theory is then applied to the main topic which is the development of a method of approximating to a *constant*, which leads again to a Chebyshev approximation.

In the final Chapter 15 which is headed " Illustration " the various topics of the book are illustrated by unifying examples. Three examples are given which show the methods of approximation and realisation in great detail. The book concludes with three appendices. In Appendix A on computation, the most efficient arithmetical techniques for performing the more common computations in network theory, whether by hand or machine, are discussed. These include the evaluation of rational functions, the solution of simultaneous linear equations and the determination of the zeros of polynomials. Appendix B contains graphs and tables of a special function which was introduced in Chapter 8 for the approximate graphical computation of the real part of a driving point function from its imaginary part or vice versa. The steps involved are illustrated by examples. Finally, in Appendix C, a bibliography of some 300 important sources is given, to which reference is made throughout the text.

It will be seen from this brief review of the contents that all the important synthesis methods are treated in the book. Since some 1100 pages are devoted to this, the various topics are presented slowly and in a leisurely fashion. There are many sections throughout in which the main steps in the argument and the key results are emphasised and clearly stated. This, together with the enthusiastic style adopted by the author, makes the book very readable. No use is made of matrices, but in a few places a very elementary knowledge of the Laplace transformation is assumed. Hence the book could be read with benefit by students in the final year of a degree course. It can be used both as a textbook and as a reference book for engineers engaged in the application of network theory. A valuable feature is the inclusion throughout the text of worked examples, some of them elaborate and long. In addition there is a large selection of problems of a wide range of difficulty at the end of each chapter. In all, the book contains over 1000 problems.

The production and the layout are first-rate. The author is to be congratulated on the result of his labours—a really excellent book. Unfortunately its price will put it beyond the reach of the individual English student, but a copy should be available in the library of every University and Technical College.

A Practical Guide to the Design of Steel Castings. The British Steel Castings Research Association, East Bank Road, Sheffield, 2. Price 12s. 6d.

THE aim of this book is to provide designers with the essential rules which should be followed when preparing their drawings, so as to ensure the economical production of sound castings. This purpose is served in admirable degree. Chapter I deals with the physical, mechanical and magnetic properties of cast steel ; also its foundry properties. The fluidity increases with the degree of superheating above the melting point. It is determined by using a spiral mould, the molten metal being poured in at one end. The length of the path followed before solidification occurs is a measure of the fluidity. The patternmaker's allowance for contraction for cast steel is $\frac{5}{16}$in to $\frac{1}{4}$in per foot ; compared with $\frac{1}{8}$in to $\frac{11}{64}$in for cast iron. A value of $\frac{7}{32}$in is usually adopted, but contraction varies in different parts of the casting. Chapter II covers foundry defects attributable to bad design, classified as : (*a*) shrinkage cavities ; (*b*) contraction tears and cracks ; (*c*) pinholes and blowholes. This very instructive section shows diagrammatically the position and extent of the defects in relation to the design, the means of preventing the defects being similarly indicated.

Chapter III deals with the design rules, not depending on the direction of moulding and pouring, which should be applied when considering the general shape of castings. Matters covered are the mechanical strength of castings, the selection of wall thicknesses, precautions against the occurrence of hot spots, dimensional characteristics of holes, precautions concerning closed sections, precautions concerning accuracy of dimensions and measures that simplify machining. Defective and correct design are often compared diagrammatically. The effect of the accumulation of metal at web junctions is correlated with the area of the resulting defect. The use of chills to prevent or minimise defects is illustrated. The principles governing the provision of ribs, and the use of recessing to obtain sound castings free from tears, are fully covered. It is noted that hot spots due to overheating of the sand can be avoided by ensuring that cores and mould parts are at least twice as thick as the metal round them. Chapter IV deals with the design rules depending on the orientation for pouring and moulding ; such as the determination of the pouring direction, the determination of the economical moulding direction as a function of that of pouring, directional solidification, arrangements facilitating moulding, and a general example—being the design of a pivot frame—typifying the rules put forward, and demonstrating their application. The results of good and bad design, or operation, are shown as diagrams, and the methods of correct design and operation are fully discussed. Designers of steel castings will study this book with profit ; those concerned with iron castings should also not fail to read it.

Solutions of Problems in Structures. By PROFESSOR W. T. MARSHALL. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 27s. 6d.

THIS book is not a textbook on the fundamental theory of structures. It concentrates on the solution of various problems based on the fundamental theory, and gives examples for the student to work through himself. Many of these examples are taken from degree examination papers, and the book is intended for the degree student. There are more than 350 problems, covering those fields of structural theory normally included in the degree syllabus in civil engineering.

Books Received

The Performance and Design of A.C. Commutator Motors. By E. Openshaw Taylor. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 45s.

The Junction Transistor and its Applications. Edited by E. Wolfendale. Heywood and Co., Ltd., Ingersoll House, 9, Kingsway, London, W.C.2. Price 84s.

Automobile Electrical Equipment. 6th Edition. By A. P. Young. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 30s.

Handwriting : A National Survey. By R. Piggott. George Allen and Unwin, Ltd., Ruskin House, 40, Museum Street, London, W.C.1. Price 25s.

Obituary

JOHN LAMB, O.B.E.

MARINE engineers, both in this country and abroad, will have learned with feelings of regret of the death of John Lamb, which occurred in London on August 12. Mr. Lamb had been associated with the development of the oil engine as a main propulsion unit and the results of his work were made available to all marine engineers through the medium of papers read before various technical bodies. His textbooks on the running and maintenance of marine diesel engines and the operation of motorship auxiliary machinery have long been recognised as standard works on marine engineering. John Lamb was born in Northumberland on August 24, 1890, and served an engineering apprenticeship with Clarke, Chapman and Co., Ltd., after which he went to sea, and gained his early experience with oil engines. It was in August, 1919, that he joined the Anglo-Saxon Petroleum Company, Ltd., and the following year he was appointed chief engineer of the motor tanker " Ortinashell." He continued at sea until 1924, when he came ashore in the capacity of superintendent engineer, and was responsible, under Mr. Zulver, for the construction of double-acting Werkspoor engines for several ships of the company's fleet. In 1938, he resigned his post to join F. J. Trewent and Proctor, Ltd., the consulting engineers and naval architects, but rejoined the Anglo-Saxon Petroleum Company, Ltd., as manager of the technical division about two years later. Mr. Lamb was made manager of the research and development department in 1948 and became a director of Shell Tankers, Ltd., on its formation in 1953 ; he also formed a company with the title John Lamb Publications and Inventions, Ltd. During the war years he was concerned with, among other assignments, the conversion of oil tankers to merchant aircraft carriers, and the development of a fireproof lifeboat. Since then he took the lead in the development of burning heavy fuel oil in diesel engines, in which work the machinery of the tanker " Auricula " was used for test purposes, and for a paper on this subject he was awarded the Denny Gold Medal by the Institute of Marine Engineers. He also investigated the question of the cathodic protection of the oil compartments of tankers and for his work on the prevention of explosions in crankcases the Institution of Mechanical Engineers gave him the Akroyd-Stuart prize. Among his major interests in recent years were the experiments towards the development of gas turbines for marine propulsion, in which the tanker " Auris " acted as a test bed. The results of this pioneer work were given in a paper entitled " Operation of Marine Gas Turbine Under Sea Conditions," and gained him his second Denny Gold Medal.

A. W. DAVIES

WE have learned with regret of the death of Mr. Albert W. Davies, which occurred, in Glasgow, on August 12. He was formerly the works director of Mavor and Coulson, Ltd., in whose service he spent practically the whole of his career. Mr. Davies served an apprenticeship with an engineering firm in Staffordshire and after its completion in 1896 joined Mavor and Coulson, Ltd. Mr. Davies was, in turn, foreman, shop manager and works manager, and in 1920 was appointed to the board as works director. He retired from the board in 1948, though he continued as one of the firm's technical advisers up to the time of his death.

Development of a 75h.p. Dynamometer Equipment

By H. A. G. FLETCHER, B.Sc., A.M.I.Mech.E., and J. BAMBOROUGH

For investigations proceeding at the Mechanisms, Metrology and Noise Control Division of D.S.I.R., East Kilbride, development work is being carried out on a dynamometer equipment for measuring losses in mechanical power transmission units, in which it is necessary to measure the losses to ±0·1 per cent of the full load torque. In this description particulars are included of the construction of the equipment, its calibration and the results obtained.

THE dynamometer equipment described in this paper is intended for use in a programme of research and investigation into losses in power transmission units of a mechanical nature in which it is necessary to measure the losses to within ±0·1 per cent of the full load torque. Since dynamometers capable of this degree of accuracy are not generally available, the development of suitable equipment was undertaken. Some recent developments in this field include a 60,000 h.p. hydraulic dynamometer (Brown, 1954), in which an accuracy of better than ±0·08 per cent may be achieved at torques higher than 50 per cent of full torque. A driving dynamometer with a capacity comparable to the present equipment and incorporating a mercury manometer torque measuring device has been shown to be accurate to ±0·09 per cent (Firth, 1954).

In the above two examples, the equipment consists of either a driving or an absorbing unit, but in order to cater for tests on fixed or variable speed drives as required in the present research programme, both types of unit are desirable. With such an arrangement the efficiency of any test vehicle may be determined by direct measurement of the input and output torques separately. Unfortunately, this method of assessment entails very precise measurement of the input and output torques and in order to achieve the required degree of accuracy, a precise weigh-beam has been developed which indicates directly the difference between these two quantities.

In order to gain experience in the design and use of trunnion bearings, two types differing from the more usual roller bearing were developed and incorporated in the equipment. The driving motor was mounted in contra-rotating ball-bearing trunnions, whilst the absorbing unit was mounted in hydrostatic oil-trunnion bearings. Tests were carried out on both units in order to determine the performance of each type and to compare them with the conventional roller bearing.

The equipment described below is a prototype on which development is proceeding and some further refinements are mentioned at the end of the paper.

General Description of Equipment

A diagrammatic arrangement is shown in Fig. 1, and a view of the complete equipment in Fig. 2. The driving motor, rated at 75 h.p. at 2000 r.p.m., is swung in contra-rotating ball bearings and the electrical supply is carried through mercury cups, thus avoiding the use of heavy cables which may tend to restrict the movement of the casing. The ventilating fan motor is supplied through a light, suspended cable. The absorbing unit is an eddy-current brake which has been modified by fitting hydrostatic oil bearings in the trunnion mountings and improving the cooling water supply arrangements. For example, the water was originally supplied through a rubber hose which has now been replaced by a tundish fitted to the casing, into which water is poured. The armouring previously surrounding the field supply cable has been removed because it tended to restrict the movement of the casing.

The torque reactions of both machines are applied to cylinders of the ported type, shown in Fig. 3, and oil pressures proportional to the driving and absorbed torques are created in the torque-weighing pressure lines. These oil pressures are fed to two cylinders, as indicated in Fig. 1, which form part of a precise weigh-beam illustrated in Fig. 4. The moment arms of these cylinders are set to suit the speed ratio of the unit under test, so that if such a unit has an efficiency less than 100 per cent, a torque proportional to the loss will be applied to the weigh-beam. The position of the jockey weight can be adjusted to bring the weigh-beam into balance and this distance is a measure of the torque loss in the unit under test. The jockey weight has alternative values of 5·8 lb, 10 lb, 15 lb and 20 lb in order to facilitate " scale changing." In order to minimise friction, all pistons are rotated continuously in their cylinders and the weigh-beam is supported on a hydrostatic bearing. The torque reactions of both driving and absorbing units can be measured, using pressure gauges of high quality.

Measurement of the speed of the input and output shafts is determined by means of a two-channel electronic counting unit.

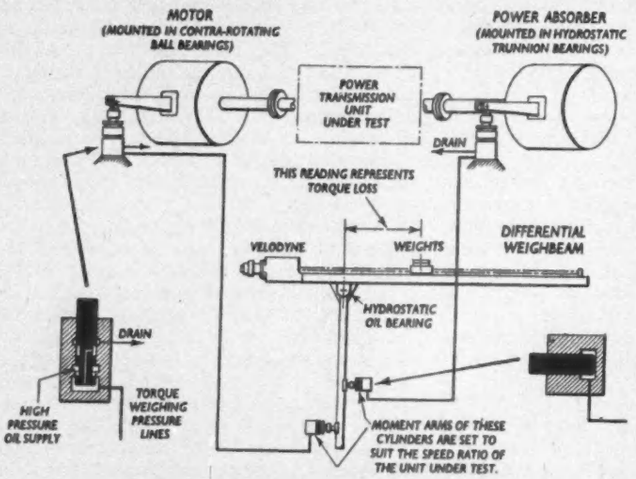


Fig. 1—Diagrammatic arrangement of dynamometer equipment

Trunnion Bearings

(*a*) *Contra-rotating Ball Bearing Assembly.*—The design of the trunnion bearings used on the driving unit is shown in Fig. 5. The motor casing was modified by fitting trunnions at each end on which deep-groove ball bearings were located. The outer race of each ball bearing is held in a gear ring assembly which also forms the inner race for needle rollers. The gear rings are driven at equal speeds in opposite directions by electric

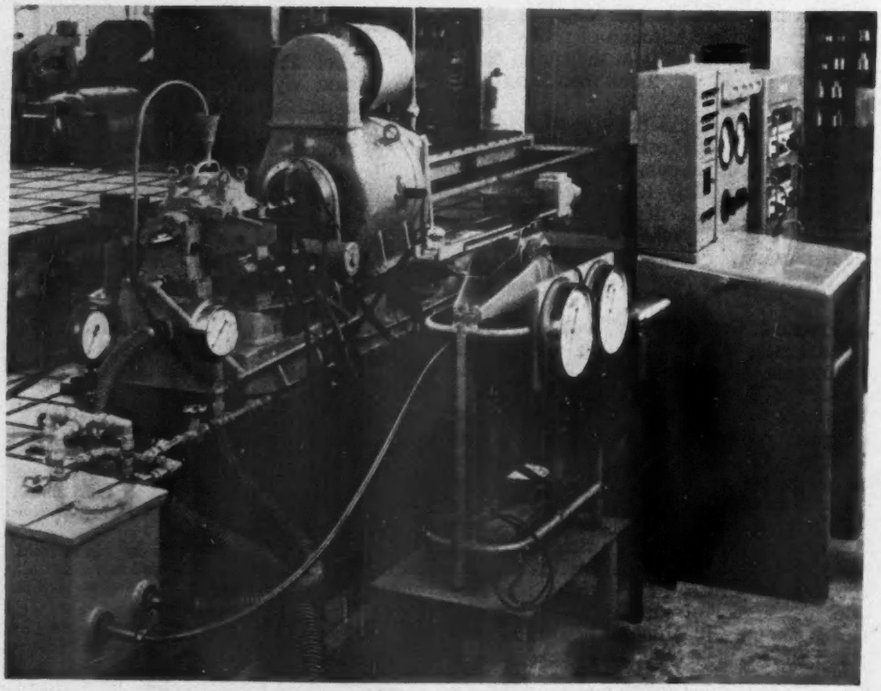


Fig. 2—General view of dynamometer equipment

motors, so that the friction torques of the ball bearings tend to cancel out. Axial location is necessary on one bearing only, and is provided by ball bearings (not shown in Fig. 5) running against the faces of one gear ring. Lubrication with a light oil is by drip feed.

The main design details of the contra-rotating ball bearings are given below.

Ball bearings	Hoffmann M.S.21.EP "00" fit. 0·0015in to 0·002in clearance
Rollers	Hoffmann 3·5mm diameter by 29·8mm long
Inner roller track	10·2677 −0·0005in diameter
Outer roller track	10·5468+0·0005in bore
Hardness of roller tracks ...	800 HD.
Diametral clearance of needle roller bearing	0·0045/0·0035in specified 0·0035in as manufactured
Speed of gear ring	47·6 r.p.m.
Weight of motor	1700 lb approximately

Great care was exercised in the manufacture of the bearings in order to maintain a high degree of circularity of the ball and roller track surfaces. No difficulty has been experienced in their use from obvious sources of trouble such as dust particles which might

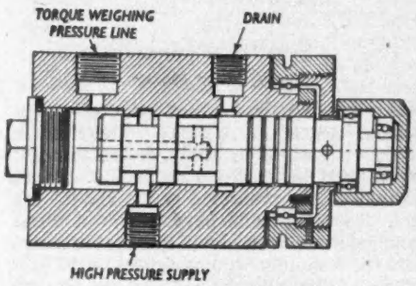


Fig. 3—Ported piston valve

get into the ball bearings and upset the balance of torque.

The sensitivity of the contra-rotating ball bearing assembly in relation to that of the conventional roller bearing was determined indirectly by noting the minimum torque required to rotate the motor casing when the outer race of each ball bearing was stationary and then allowed to rotate at a speed of approximately 47 r.p.m. The motor was first balanced statically and the movement of the motor casing for a given applied torque was determined by means of an auto-collimator.

With the outer race stationary it was found that the torque varied with the movement of the casing as shown by curve *A* in Fig. 6 in which the plotted results represent the mean of two sets of observation.

It will be noticed that a torque of the order of 2 oz-in is sufficient to move the casing by an amount (0·0015in) equal to the underlap of the piston valve. This point is discussed in the conclusions.

When the outer race is rotating a torque of 2 oz-in applied to the motor casing is sufficient to cause positive and continuous movement, see Fig. 6. (Curve *B*.)

(*b*) *Hydrostatic oil-trunnion bearings.*—The absorbing unit is fitted with two hydrostatic oil-trunnion bearings as shown in Fig. 7. Both bearings are of the same type, axial location of the floating parts is provided by the unit to which the absorbing unit is coupled. The mode of operation of this type of bearing is as follows. When the journal is eccentric in the bush, the clearance will vary around the bearing. Where the clearance is large, the resistance to flow from the pocket to atmosphere will be low compared with the resistance to flow at the throttle, and the pressure in the pocket will be correspondingly low. Where the clearance is small, the converse applies and the pocket pressure will be correspondingly high. The bearing, therefore, tends to be self-centring.

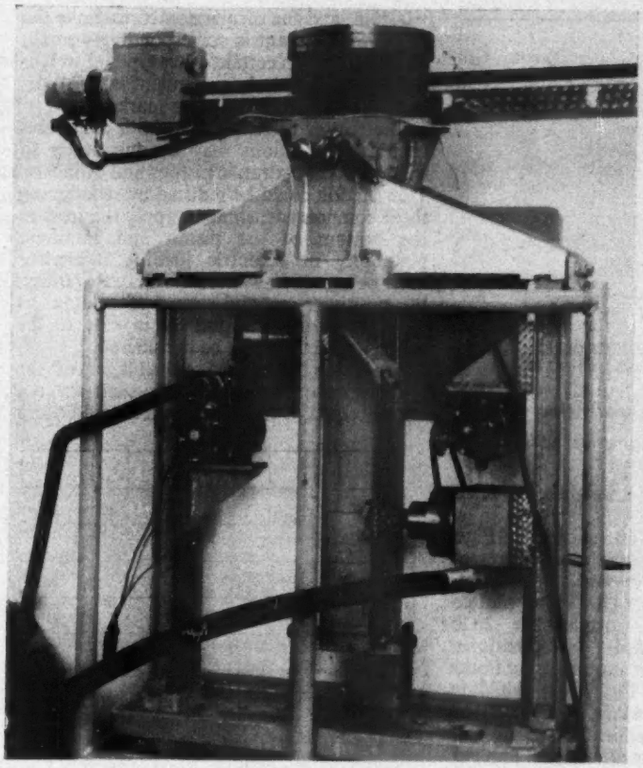


Fig. 4—View of weigh-beam

With the absorbing unit uncoupled from the driving unit it was found that the resistance to movement of the absorber casing was less than 1 oz-in.

These bearings have proved satisfactory in use, and are relatively simple to manufacture. The oil supplied is filtered to 5 microns by full-flow filters, and whilst it was necessary to clean the bearings a short time after installation, no trouble from dirt has been experienced in the subsequent two years' running.

The design details of these bearings are given below :

Weight of floating parts	621 lb
Bore of bush	3·25in
Length of bush...	2·375in
Diametral clearance	0·006in nominal
Length of pocket measured in axial direction	0·875in
Width of pocket	0·625in
Number of pockets	10
Throttle size	0·016in drill
Load per bearing	310½ lb
Viscosity of oil at normal running temperature	30 centistokes at 75 deg. Fah. approximately
Oil supply pressure	200 lb per square inch

Note.—The viscosity and temperature of the oil vary, but the values given are typical of running conditions.

Calibration of Complete Equipment

(*a*) "*Static*" *calibration of weigh-beam.*—In order to simulate a loss of power between the input and output of a unit under test it was necessary to apply a higher torque to the motor casing than to the absorber casing. This caused the weigh-beam to become unbalanced and the position of the jockey weight was adjusted so as to bring the beam into balance again. The distance through which the jockey weight was moved was then a measure of the additional torque applied to the motor. The additional torque applied to the motor casing varied from about 1·5 to 18·5 lb ft and the corresponding movement of the jockey weight on the weigh-beam was noted. The relationship between these two values is shown by the curve in Fig. 8. Three sets of measurements were made for each position and the range of reading was generally within ±0·02 per cent of the full motor torque (197 lb ft).

In these tests, the ventilating fan on the driving unit was run, as this would normally be the case when the motor was in use. The driving unit and absorbing unit were not coupled, so that the effect of rotor-bearing friction was eliminated.

(*b*) *Motor windage.*—The motor is not fitted with windage correctors and, therefore, tests were carried out to determine the windage reaction. This was achieved by running the motor uncoupled at various speeds, and balancing the windage torque with deadweights. The results are plotted in Fig. 9.

The windage is very small, being approximately 0·016 per cent of motor full torque at 2000 r.p.m. This value is extrapolated, as at this speed continuous swinging of the motor made it impossible to obtain a value.

(*c*) *Running calibration.*—In the previous static calibration tests, Section 4 (*a*), the rotors of both driving and absorbing units were stationary and uncoupled. Certain factors such as slight unbalance of the rotors, speed changes, air and water windage, &c., might be expected to affect the equipment when used normally. In order to investigate this, the driving and absorbing units were run directly coupled and the power was varied from the minimum to the maximum. Tests were carried out at various speeds from 250 r.p.m. to 2000 r.p.m. with motor driving torques from zero to 195 lb ft approximately. At each condition of test an additional torque was applied to the motor casing by dead

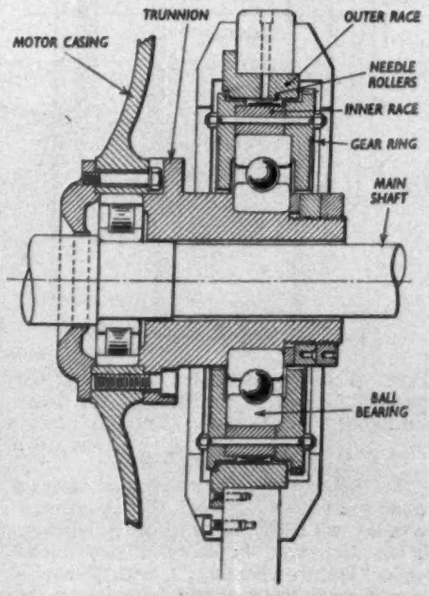
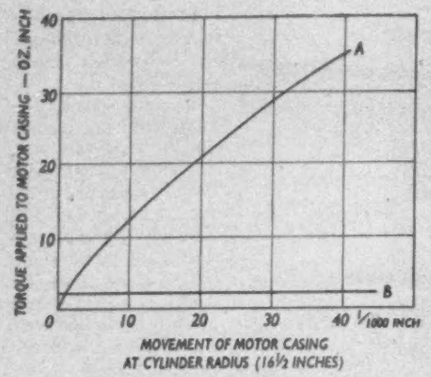


Fig. 5—Contra-rotating ball bearing assembly



A.—Outer race of ball bearing fixed
B.—Outer race of ball bearing rotating

Fig. 6—Motor casing movement on application of torque

weights, and appropriate weigh-beam readings were taken.

Some typical results are shown in Figs. 10 (*a*) and 10 (*b*), in which the curves represent weigh-beam readings expressed as a percentage of full motor torque (197 lb ft) plotted against motor driving torque, the 20 lb jockey weight being used. No additional torque was applied to the motor casing in the case of tests plotted in Fig. 10 (*a*), whilst in the case of tests plotted in Fig. 10 (*b*) an additional torque equivalent to 3·62 per cent of full motor torque was applied. Curves for only two speeds of 250 r.p.m. and 2000 r.p.m. are shown, but are representative of the spread in the calibration occurring over the speed range. In general the distribution of readings is such that curves for the lower speeds tend to lie towards the low side of the band, and curves for the higher speeds towards the high side of the

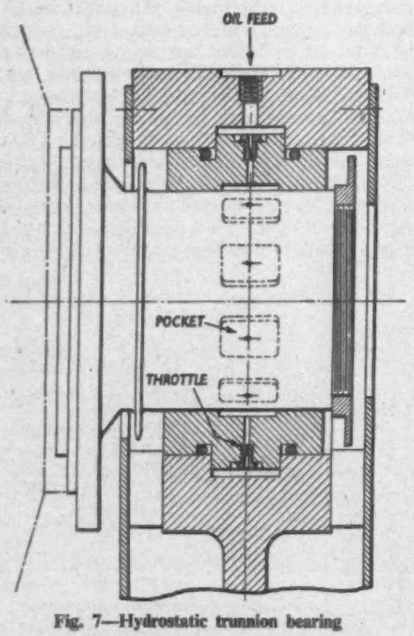


Fig. 7—Hydrostatic trunnion bearing

band. This general pattern is typical of the results obtained in the case of the other values of jockey weights.

Discussion of Results

The improvement over the usual ball- or roller-bearing trunnion of either the contra-rotating ball bearings or hydrostatic bearings is less than might be expected (see results under "Trunnion Bearings"). With this equipment the movement required to operate the weighing gear is small, being of the order of 0·0015in, and the torque needed to move the casing this amount is correspondingly small, see Fig. 6. With certain other types of weighing gear, in which the movement is large, the improvement might be more marked.

The scatter of readings in both static and running calibrations may be due partly to friction in the hydraulic pistons and cylinders. This friction could be reduced by redesigning these components, so as to apply the load to the bottom of the piston and minimise possibility of eccentric loading (Silverleaf and Berry, 1957—Discussion). Regarding the positive slope and scatter of readings as shown by bands (*a*) and (*b*) in Fig. 10 the following factors may be considered.

(*a*) If the mechanical advantages of the two halves of the weighing system are not exactly equal, then an unbalance would occur

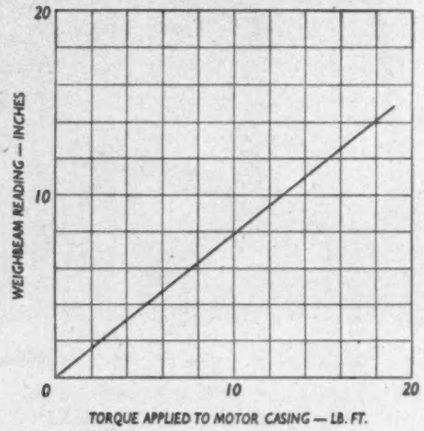


Fig. 8—Static calibration of weigh-beam

and cause the bands to slope. An adjustment was made, but on trial it was shown that this was not the complete picture.

(*b*) The other main variables with increasing motor torque are motor armature current and absorbing unit field current. The motor armature is shielded by the field, and the casing stops are of brass to minimise magnetic effects. In the absorbing unit there is a strong magnetic field in the casing under normal operating conditions, and there are two magnetic circuits via the ported cylinder and via the trunnion pedestals. In this case magnetic effects could be minimised by the use of non-magnetic materials for bearing pedestals and cylinder brackets.

In considering the equipment as a whole some further requirements could be made :

(i) Driving and absorbing units should be balanced dynamically and statically to a high degree of accuracy. In particular, machinery with wound rotors could be rebalanced after the windings had settled with running.

(ii) The eddy current absorbing unit could be replaced by a generator which may be less liable to the magnetic effects (see below).

(iii) Care should be taken to minimise magnetic field effects.

(iv) The driving unit motor is at present supplied by a mercury-arc rectifier. This could be replaced by a Ward-Leonard set to minimise transient variations in the mains.

(v) The motor and brake could be back-loaded to relieve the hydraulic system of load, and hence reduce friction in cylinders.*

In estimating the overall accuracy to which a measurement can be made, it was necessary to examine all the running calibration readings in relation to the static calibration on graphs of which Fig. 10 is typical. At the present stage of development, the amount of

* Many of the suggestions mentioned above for improving the sensitivity and accuracy are being incorporated in a larger unit of 300 h.p. capacity.

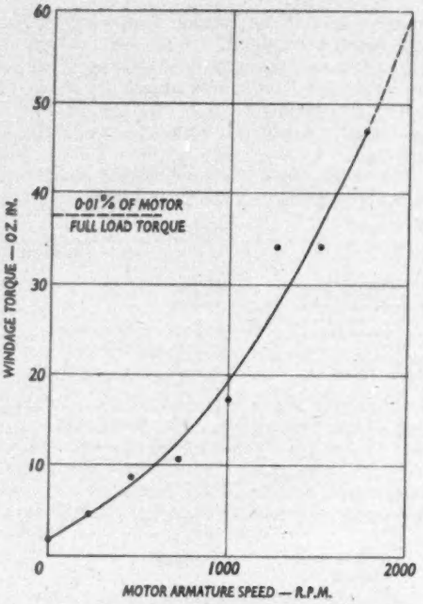


Fig. 9—Motor windage

motor windage is small in relation to the general scatter of readings. Therefore it seems reasonable to apply the corrections, represented by graphs such as Fig. 10 (*a*), entirely to the absorbing unit. The driving and absorbing units have been run direct coupled in order to obtain these calibrations, and the maximum driving torque is 197 lb ft whereas the absorbing unit can absorb 328 lb ft torque. Hence the corrections to be applied would need to be extrapolated for absorbed torques 66 per cent higher than the maximum at which the tests have been carried out. This point is important when

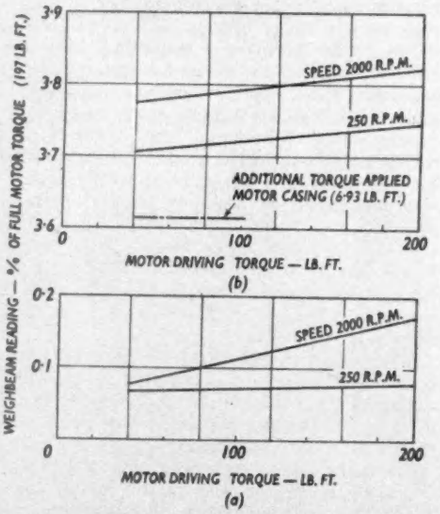


Fig. 10—Running calibration for 20 lb jockey weight

the test vehicles operate at different input and output speeds.

From the evidence available, the accuracy of measurement is of the order of ±0·1 per cent of the full motor torque.

Acknowledgments

The work described was carried out in the Mechanical Engineering Research Laboratory, and is published by permission of the Director.

References

[1] Brown, T. W. F., "The Measurement of Power," *Inst. Naval Architects*, 1954.

[2] Firth, D., "Electric Dynamometer Supported on Pneumatic Trunnions and Having Hydraulic Torque Measurement," *M.E.R.L. Fluids Report No.* 23, 1954.

[3] Silverleaf, A., and Berry, L. W., "Recent Work in the Lithgow Water Tunnel at N.P.L.," Discussion, *Inst. Engineers and Shipbuilders in Scotland*, 1957.

Copy Grinding with Abrasive Belts

A copy grinding machine which uses an endless abrasive belt technique to reproduce the form of a master pattern on workpieces to high precision limits has been developed by Cyril Adams and Co., Ltd. The machine works in an automatic cycle and can be operated by relatively unskilled labour. It was primarily designed to provide a simple economic machine for grinding aerofoil forms on gas turbine and compressor blades, but is well suited for many other kinds of finish copy grinding on such parts as forgings and pre-machined components.

Abrasive belt copy grinding machine with hinged hood swung down ready for operation

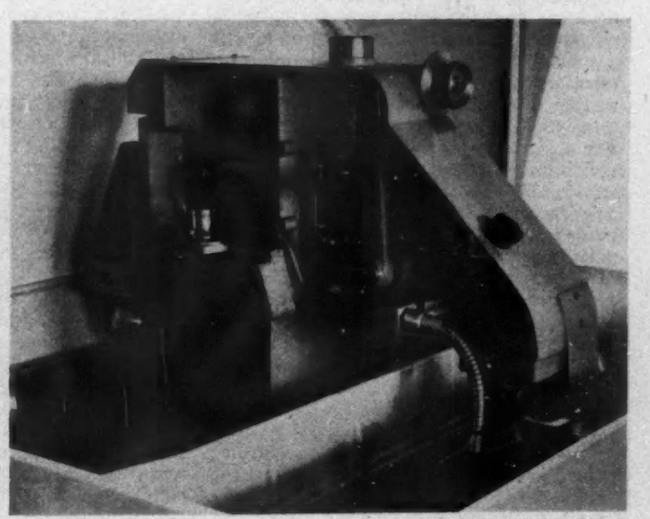
A PRECISION copying machine, which has been developed by Cyril Adams and Co., Ltd., 155, East Barnet Road, Barnet, Herts, for grinding aerofoil forms on gas turbine and compressor blades and other similar forms, is based upon a principle of belt grinding originated by Armstrong Siddeley Motors, Ltd. It works upon a relatively straightforward principle of 1 to 1 reproduction from a master form, and the machine consists of a central column vertical slide assembly within the upper table which consists of a work table at the front and a master pattern table at the rear. The rising and falling slide of the column carries a belt grinding head and a roller follower which register over respective work and master form mounting tables. As the upper table is reciprocated longitudinally the roller follower raises and lowers the grinding head, and the incremental cross traverse of the head combined with the reciprocation of the upper table reproduces the contour of the master on the workpiece as it passes below the grinding head. The machine is easy to set and operate and has a fully automatic cycle which makes it applicable to a wide range of industrial machining where formed components have to be ground to close tolerances on one face. Although machines are at present being made to grind work up to some 14in long by 5in wide, we understand that it is proposed to make equipment of larger capacity when required.

Grinding is effected on the machine by a continuous belt which is some 130in long by $\frac{3}{4}$in wide and driven at 6500ft per minute. The special class of belt used produces a very fine swarf as distinct from a dust as is usual with abrasive grinding wheels, and it imparts a very high standard of finish to the work. A jet of cutting fluid is maintained at the point of belt contact with the workpiece and this combined with the high belt speed ensures clean cool grinding with long effective belt life. It has been found that between sixty and 160 components can be completed by each belt, depending upon size and material, and normally a belt fails by breakdown of its joint before its abrasive coating has become ineffective. Another feature of this method of grinding is that need for wheel truing is eliminated and the setting is maintained. Depending upon the material being ground depths of cut can vary from 0·003in on high-grade heat-resistant steel to 0·050in on aluminium without distortion.

The general design of the machine can be seen from the photographs we reproduce. The main cabinet base carrying the table assembly has an open centre in which the main column assembly is mounted. The upper table is a one-piece casting with a platform at the front, on which the workpiece is mounted, and a platform at the rear, on which the master pattern is fixed ; the two platforms being coupled rigidly by bridge sections at each end. This upper table is mounted on longitudinal vee ways on a cross slide and is reciprocated by the piston of a hydraulic cylinder at speeds variable between 5ft and 10ft per minute. The cross slide through which transverse feed is effected is moved by a feed screw driven through a rack and pinion by a hydraulically operated pawl and ratchet gear. This cross feed mechanism can be set to give any of nine feed rates of 0·005 ; in between 0·005 and 0·045in per table stroke.

The column assembly comprises a deep vertical support structure fixed to the cross slide and housing internal slideways in which the main "T"-shaped column is guided. Rigid fore and aft arms at the top of the column carry, respectively, the grinding assembly and the follower assembly, and the 1 h.p. driving motor for the grinding belt is mounted on the foot of the column. A hydraulic cylinder in the base of the machine is used to raise and lower the column over a distance of some $3\frac{1}{2}$in. The piston of the hydraulic cylinder is retracted whilst the machine is in operation, leaving the weight of the column counterbalanced in such a way that a constant load of about 12 lb is imparted on the master pattern by the follower roller. The column is then free to be raised and lowered by the follower roller as it passes over the contour of the pattern as the tables reciprocate, and this movement is reproduced in the front arm of the column carrying the grinding belt contact roller.

The column head assembly can be clearly



Grinding head of machine with covers removed to show (left) the grinding band with the contact and guide wheels, and (right) belt tension pulley actuating lever. In the right-hand view the follower roller can be seen in contact with a master pattern on the rear table

seen in two of the photographs we reproduce. The standard grinding belt contact roller and the follower roller are each 3in diameter and they have corresponding spherical faces. With them a minimum concave radius of 1½in can be traced and ground on a workpiece, but special units can be provided for reproducing smaller radii if required. A "Neoprene" facing is fitted on the belt contact roller and on the free guide rollers over which the belt passes. The grinding belt run is taken down the hollow column to the main driving pulley at the foot and its change of direction over the pulleys has a secondary effect in releasing swarf which may be trapped between the grains of the abrasive coating. One of the guide rollers is mounted on a spring loaded bearing block which maintains the required belt tension during grinding. This block can be raised by a self-locking handle to release the tension for belt changing.

The follower roller is mounted on a slide which can be moved up and down by a lead screw operated by a cross shaft terminating in a knurled knob at the front of the head. This knurled knob has a micrometer graduated disc and through it vertical adjustments are made to the follower slide to give the required feed depths. It will be appreciated that upwards feed movement of the follower slide lowers the belt contact wheel in respect to the work owing to the free vertical float of the counterbalanced column. It will be noted that the contact grinding belt wheel is open-sided to enable grinding up to shoulders on work blanks. Shoulders with a root radius below about ⅜in cannot be ground.

A somewhat unusual method of cross feed during grinding has been adopted on the machine to eliminate a band which normally appeared at the side of the work at the end of each table stroke. In the method used incremental cross feed is made at the middle of each stroke when a dog on the table depresses the plunger of a micro switch actuating the feed mechanism. On the subsequent return stroke a second grinding pass is made over the area already ground in the previous stroke to give a "sparking-out" effect. When the centre line is reached cross feed takes place to give a full metal removal over the remainder of the stroke. This sequence of finished and preliminary grinding strokes is carried over the full area of the workpiece. It gives a particularly high standard of finish which, depending on the grit of the belt, can be as low as 10 micro inches C.L.A. on stainless steel in normal production. The machine has a fully automatic grinding cycle at the end of which it stops and the head rises ready for the unloading and replacement of a work blank.

Metal Spraying Pistol

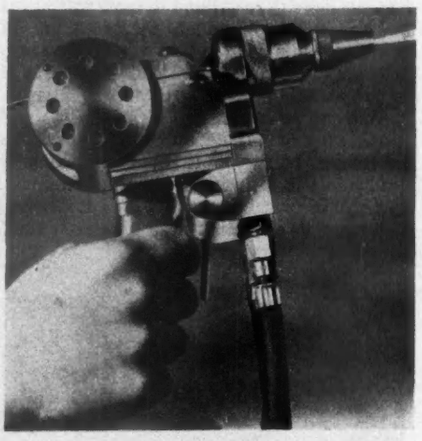
An improved design of metal spraying pistol, known as the "Mark 33," has been introduced by Metallisation, Ltd. This pistol is adaptable for spraying metal wire from 2mm to 3/16in diameter and has a stepless range of feed speeds from 2½in to 16ft per minute. The full range of wire sizes and feed speeds are covered without need for changes in the feed transmission gears or feed rollers. A new form of feed drive control ensures that full power is available from a constant speed air turbine throughout the feed speed range. It is stated that the pistol is capable of spraying up to 62 lb of zinc per hour, or 15 lb of aluminium per hour, or 10 lb of steel per hour.

FOR some thirty-five years Metallisation, Ltd., Pear Tree Lane, Dudley, has specialised in the manufacture of spray pistol equipment for the deposition of metals for the protection of structures against corrosion, for the building-up of worn parts and for decorative purposes. With this technique, as is now well known, any metal which can be drawn into a wire and melted in an oxy-gas flame can be deposited on almost any metallic or non-metallic material. An important step in the technique was made by the firm when it introduced the "Mark 16" pistol nearly twenty years ago, and since then this design of pistol with but minor modifications has been widely used with considerable success. Based upon the experience with the "Mark 16," it was decided a year or so ago to develop a pistol of universal design which would incorporate a number of improvements and eliminate the loss of time involved hitherto in changing nozzles and wire feed rollers when switching over from one wire size to another. It was also decided to introduce another form of feed roller drive in which the torque would be constant irrespective of the air turbine speed. In the standard tool, wire feed speed is varied by controlling the air supply to the turbine and an accompanying loss of torque at the lower speeds makes necessary occasional attention on the part of the operator to ensure even deposition of the metal being sprayed.

The new "Mark 33" universal metal spraying pistol which the firm has now placed in production after extensive trials is designed to cover wire sizes from 2m.m. to 3/16in without need for feed roller changing or adjustment. This full wire size range is handled by only four quickly interchangeable nozzles. A steplessly variable wire feed speed range from 2½in to 16ft per minute is provided by a constant speed air turbine working in conjunction with a magnetic speed control mechanism which ensures constant torque at all speeds. With compressed air at 60 lb per square inch, the consumption of the tool is 22–23 cubic feet per minute. Typical deposition rates with the pistol are given as 62 lb per hour with zinc; 15 lb per hour with aluminium, and 10 lb per hour with steel. As can be seen from the accompanying illustration, the pistol is of clean, practical design; its total weight of 5 lb is well-balanced on the pistol grip handle to reduce operator fatigue to a minimum. A single thumb lever controls in one movement the gas and air supply valves, a knurled knob the wire feed rate, and a second thumb lever opens and closes the wire feed rolls. Particular attention has been paid to ease of maintenance and the whole pistol can be quickly stripped down for replacement of worn parts, when necessary, with the use of only a few standard tools.

The general construction of the tool can be seen in the drawings we reproduce. The wire feeding mechanism consists essentially of a compressed air-driven turbine, a gearbox, a wire feed roller assembly and a speed control unit, all of which are grouped as a single unit within the main body casting of aluminium alloy. The air turbine *A* of curved blade design, is secured on a transverse main shaft which, through worm and wormwheel, drives a countershaft extending longitudinally along the full length of the body. Near the inner end this countershaft has machined on it a worm which is set between and meshes with the wormwheels of a pair of spaced vertical shafts carrying the wire feed rollers. Two sintered steel brackets in which the feed roller shafts are mounted are pivoted at the lower end about the countershaft, and at the upper end the roller shafts, through the brackets, are spring-loaded inwards towards each other. With this arrangement a positive drive is imparted through the worm gearing to the feed roller shafts, whilst they can incline towards or away from each other to suit varying diameters of wire between their serrated rollers. A lever at the side of the pistol body is depressed to open the rollers when feeding in a new wire, and the spring loading on the wire feed rollers can be adjusted through a grub screw to impart the required gripping load on the wire.

The wire feed speed control mechanism fitted to the pistol is very sensitive in operation and is designed to respond instantaneously to the slightest change in speed of the air turbine power unit and automatically release to the turbine the precise amount of air required to maintain a pre-set constant speed regardless of variations in loading. Through this control mechanism the wire feed speed can be regulated over an exceptionally wide range, so making it possible to spray both high and low melting point metals without need for making changes in gearing. This speed control mechanism consists of two principal parts. A magnetically-operated pilot valve controls a bleed of air to a



Metal spraying pistol for wire from 2mm to 3/16in diameter, capable of spraying from 62 lb of zinc to 10 lb of steel per hour

secondary air valve in the main turbine air supply and its operation can be followed by reference to a diagram we reproduce opposite. The pilot valve assembly includes a magnet cup *B* which is fixed on the end of the rotor shaft and a complementary six-pole permanent magnet *C* which is carried on a spindle in the end housing. This six-pole magnet, through its supporting spindle and a knurled knob on the side of the head, can be moved in and out of the rotor shaft cup recess and in respect to an adjacent magnetic shunt ring *D* fixed on the pistol body. A pilot air valve *E* with an exit port or orifice at the side is fixed on the body and extends

into one recess of the permanent magnet *C*. The distance of the exit port of the pilot valve from the side of the recess controls the amount of air bled through a channel to the secondary diaphragm air valve assembly *F*, attached to the base of the head. This secondary diaphragm air valve in turn controls the flow of high-pressure air to the turbine.

When the pilot valve is open a maximum amount of air is delivered to the turbine, but when the valve is closed only a very small amount is admitted. Thus, when the speed of rotation of the turbine drops below that pre-set for running, air is freely supplied to the turbine, but when the controlled speed is reached the air supply is momentarily cut off or reduced.

The secondary valve which controls the flow of air to the turbine consists of three diaphragm plates, with two diaphragms *G* and *H* interposed, and a valve plunger *J* all of which are assembled on the underside of the gear housing as a complete unit. When the gun is in operation the pressure of air taken from the main supply to the gas head of the pistol forces the upper diaphragm *G* and valve plunger downwards opening up a channel to the turbine. Air continues to flow unrestrictedly through this channel until the turbine speed reaches a pre-set limit at which the controller comes into effect. This is brought about by the closing of the pilot valve port which allows sufficient pressure to build up in the cavity *K* at the bottom of the assembly to force the lower diaphragm up. This diaphragm raises the valve plunger to cut off the air supply to the turbine.

In operation the magnet cup rotating with the turbine shaft exerts a magnetic "drag" on the magnet which causes it to turn against the pilot valve port thereby causing an air pressure to build up in the cavity at the base of the valve assembly. The magnetic shunt set in a fixed position directly opposite the magnet cup is designed to attract the magnet away from the pilot valve port to allow air to escape and relieve the pressure in the cavity. As already mentioned the position of the magnet in relation to the magnet cup can be altered by rotating the control knob. This movement has the effect of increasing or decreasing both the magnet "drag" effect and the speed at which the "drag" overcomes the attractive force of the magnetic shunt which, in effect, is the speed at which the speed controller operates. When the speed controller is fully operating, the magnet takes up a position where the pilot valve port is partly open so that the slightest movement towards or away from the port immediately changes the pressure exerted on the diaphragm valve plunger to allow more or less air to flow to the turbine as required. A small channel (*L* in the diagram) connecting the base cavity with the secondary valve outlet port delivers a small amount of air to the turbine at all times. This air supply serves mainly to smooth out pulsations which would otherwise occur owing to the extremely rapid response of the secondary valve to the magnetic pilot valve.

All of the rotating parts in the head are mounted on ball bearings and run in a sealed lubricant. The maintenance of an air space between the fixed and rotating parts of the magnetic speed control assembly eliminates the effects of friction to ensure a long working life.

The compressed air, gas and oxygen supply tubes are connected to the block below a diaphragm valve assembly *J* at the base of the combustion assembly fitted at the front of the tool. This valve block has a cam spindle *N* across its full width and when the cam is turned by a thumb lever the three plungers controlling the air, gas and oxygen inlets are forced down against the diaphragm seals to shut off the supplies. The central plunger controlling the gas supply is fitted with a secondary plunger which gives a slight leak of gas to the nozzle for the initial lighting operation. When the valve lever is in the vertical position the gases pass to their respective ports in the gas head, where the gas and oxygen are partially pre-mixed before passing to the nozzle assembly.

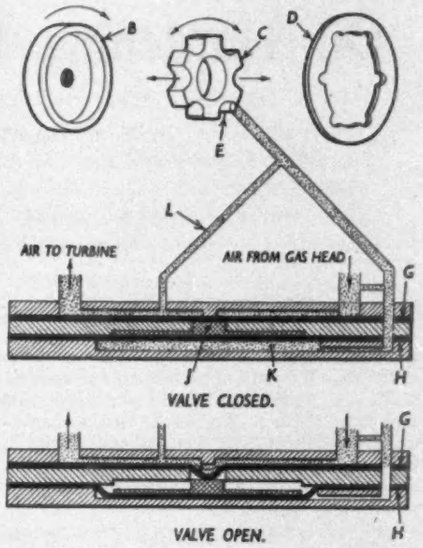
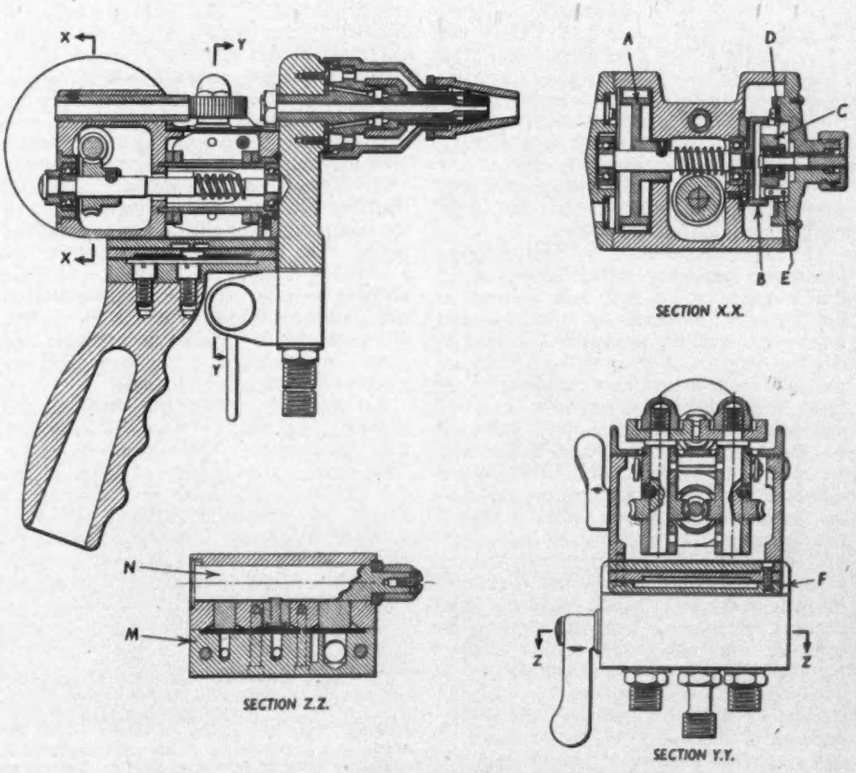


Diagram showing operation of secondary diaphragm air valve under control of magnetically controlled pilot valve

An improved design of nozzle and nozzle assembly is secured to the gas head by a single nut, and the gas nozzle is attached to the nozzle body by a lock nut. The nozzle body also carries the air cover and the air nipple. The metal-to-metal joints between the gas head and nozzle body and the gas nozzle and nozzle body are lapped to ensure gas tightness. Two slotted head screws are provided on the front face of the gas head, one marked "A" and the other "P." These screws are interchangeable and provide a quick and easy means of adjusting the relative volumes of gas to oxygen according to the kind of gas being used. When acetylene is being used the screw marked "A" is inserted in a hole indicated by an arrow on the gas head, and is replaced by the screw marked "P" when propane or natural gas is used.

We recently saw a convincing demonstration of the efficiency of the new design of wire feed drive and control introduced in the "Mark 33" pistol. For this demonstration a 40 lb weight was suspended from a feed wire between the rolls. When an air supply at some 50 lb per square inch was then switched on the weight was raised smoothly at speeds of up to 16ft per minute without any sign of slip or speed variation at any related speed. Subsequent spraying demonstrations with various types of metals showed the ease of control and high deposition rates of which the new tool is capable.



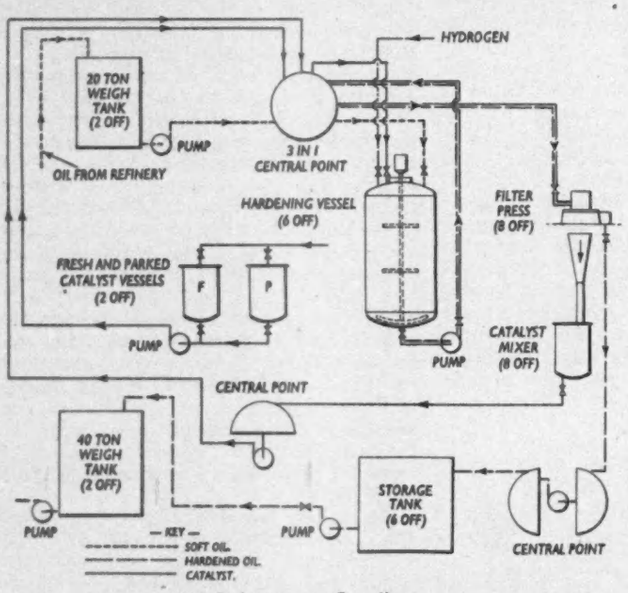
General arrangement of "Mark 33" metal spraying pistol

STORR LOCHS AND MORISTON HYDRO-ELECTRIC SCHEME ADDITIONS.—Additions to existing schemes at Storr Lochs in Skye and on the River Moriston in Inverness-shire, proposed by the North of Scotland Hydro-Electric Board, have now been confirmed by the Secretary of State. The cost is estimated to be £740,000, of which £690,000 will relate to the Moriston Project. At Storr Lochs the head waters of the River Chracaig will be diverted into Loch Fada, to allow the Board to increase the output of electricity from the Storr Lochs Project by some 1,300,000 units annually. In Glen Moriston the works proposed will extend the catchment area regulated by Loch Cluanie, the main reservoir of the Moriston scheme, and will increase the output of the two upper generating stations by some 12,200,000 units annually. A White Paper on the scheme has been published (H.M. Stationery Office, Edinburgh, price 4d.).

Oil Hardening Plant at Purfleet

To render the oil production department independent of other factories for supplies of hardened oils a hardening plant has been built at the works of Van den Berghs and Jurgens, Ltd., at Purfleet. The new equipment has been designed to produce 60,000 tons of hardened oils a year and consists of six 18-ton hydrogenation vessels and associated ancillaries.

EARLIER this year Van den Berghs and Jurgens, Ltd., put into commission at its Purfleet works a 60,000 tons a year hardened oil plant. This new equipment has made the works into a self-contained unit and thus the deterioration in quality consequent upon transport from other factories is avoided and, in addition, the hardened oils are now available in a condition of maximum freshness. Additional crude oil storage requirements have been met by constructing nearby a tank farm of 30,000 tons capacity and for the economic employment of this new capacity a reciprocal agreement with Shell-Mex and B.P., Ltd., allows the berthing of large ocean-going ships, bringing in the raw materials such as vegetable and marine oils, at that company's jetty in exchange for bunkering facilities for small craft.



Hardening process flow diagram

Process hydrogen is manufactured from hydrocarbons by a Power Gas Hercules reforming plant producing 24,000 cubic feet of hydrogen per hour. There are four main sections : the reforming furnace ; carbon monoxide conversion and carbon dioxide removal ; carbon monoxide conversion to methane ; and compression, drying and storage, and the hydrogen produced is guaranteed to contain not more than 0·1 per cent carbon dioxide, 10 p.p.m. carbon monoxide and 0·5 per cent methane. The propane, which is delivered by road tanker and stored in two 25-ton vessels, is vaporised by hot condensate and passed through activated carbon drums, for the removal of residual sulphur compounds before being fed to the reforming furnace. Mixed with steam the hydrocarbon is reformed in four catalyst filled stainless tubes which are within the furnace and heated to over 1600 deg. Fah. The gas, containing 20 per cent carbon monoxide, is cooled by condensate from the amine reboiler and then passes through a vessel where a catalyst converts the carbon monoxide to carbon dioxide and also produces additional hydrogen. Scrubbing by a solution of mono-ethanolamine in water removes the carbon dioxide, after which there is another stage of carbon monoxide conversion and carbon dioxide removal. After regeneration by boiling, the amine solution is recirculated to both the carbon dioxide absorbers. Finally the last traces of carbon monoxide are reacted to methane over a nickel catalyst at about 250 deg. Cent. The hydrogen after leaving the methanators is cooled to about ambient temperature, passes through a Wiggins dry pattern gas holder which provides buffer storage and is then compressed from 17in water gauge to 90 lb per square inch gauge before refrigeration and final storage in a Horton sphere of 32ft 6in diameter. During shut down periods the temperature of the reforming and purification sections of the plant recirculation is employed and the essential steam supplies are provided by an automatic oil-fired boiler of 3300 lb per hour evaporation. The reforming catalyst should have a life of not less than two years while it is considered that the life of the carbon monoxide conversion should be three years and that of the methanation catalyst one year.

The conversion of oils to solid fats is by the progressive saturation with hydrogen of the double bands in the fatty acid portions of the glyceride molecules of vegetable and marine oils and the process is indicated in our line diagram. Oils from the refinery are passed to the hydrogenation vessels which are fitted with agitators and provision made for adding a catalyst and the mixture is subjected to vacuum for deaeration and is heated with steam prior to hydrogenation. Hydrogen is admitted at 42 lb per square inch gauge by an automatic regulating valve. During hydrogenation the exothermic heat raises the charge to the operating temperature which is maintained by hot water pumped through coils and which produces low-pressure steam. When the process is complete the charge is cooled initially by the generation of steam from the admission of hot water and then by the circulation of cool condensate. At a temperature of 100 deg. Cent. the hardened oil and catalyst is pumped to one of eight 500 square feet filter presses which removes the catalyst and the clear oil is then pumped to storage tanks of which there are twelve of 18-ton capacity. The oil/catalyst cake removed from the filter presses is transferred to any of eight 3·6-ton re-use catalyst vessels or, if the activity has deteriorated, forwarded in drums to another works for re-activation.

To provide for the increased power demands of the new plant it was necessary to modify and renew the existing steam and power plant after an investigation of steam and power balance and of the economics of the integrated installation. Five Babcock and Wilcox oil-fired boilers have been installed outdoors with the fronts forming one wall of a covered firing aisle; each boiler has one forced draught and one induced draught fan, the latter handling flue gases, from the Senior economiser, at 400 deg. Fah. The fans are interlocked so that should the I.D. fan fail the F.D. fan would also stop and the fuel supply to the three burners be cut off. The thermal efficiency of boilers and economisers is given as 87 per cent when the economisers are supplied with feedwater at 240 deg. Fah. Feedwater is passed through a hydrogen-ion exchange unit for the removal of bicarbonate temporary hardness, and is then treated in a carbon dioxide de-gassing tower. After caustic injection the water is pumped to a sodium base exchange unit for the removal of permanent hardness, and then delivered to a 200-ton soft water storage tank. Sulphuric acid for the re-generation of the hydrogen-ion units is stored in an 18-ton rubber-lined tank and there are also two tanks arranged for the bulk delivery of salt. Fuel is stored in two 1000-ton tanks, located in a compound and is subsequently delivered to three 25-ton service tanks.

Electrical power is generated by two back pressure turbo-alternators each consisting of two turbines in line driving one alternator through an 8 to 1 reduction gear. Each turbine runs at 8000 r.p.m. and steam is supplied at 400 lb per square inch gauge. No. 1 turbine can generate 500kW and steam passes out at a back pressure of 170 lb per square inch gauge and 470 deg. Fah. and is passed through a desuperheater to the site process h.p. main at 425 deg. Fah. From No. 2 turbine, which can generate 3250kW, steam is passed out at a back pressure of 38 lb per square inch gauge and 325 deg. Fah. and then direct to the process l.p. steam main. The alternators run in parallel with the 11kV network of the Eastern Electricity Board and an agreement has been made with the Board regarding the import or export of power. The 11kV ring main switchgear has a breaking capacity of 250MVA and there are nine substation transformers of 1000kVA each, either 11kV to 415V or 11kV to 3·3kV. The ring main is installed underground and links five substations. The consulting engineers were Merz and McLellan.

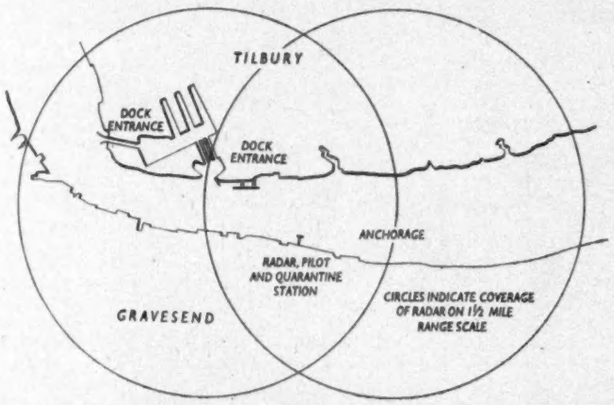
The main suppliers were :—Babcock and Wilcox, Ltd., boilers ; Senior Economisers, Ltd., economisers ; The Permutit Company, Ltd., water softening plant ; Bailey Meters and Controls, Ltd., boiler control systems ; Braithwaite and Co., Engineers, Ltd., softened water tank ; Whessoe, Ltd., fuel tanks ; Brush Electrical Engineering Company, Ltd., turbo-alternators ; Johnson and Phillips, Ltd., switchgear.

CATHODIC PROTECTION.—Cathodic Corrosion Control, Ltd., a subsidiary of Constructors John Brown, Ltd., has developed a method of combating corrosion of ships' hulls by adapting its standard CX3 line anode and incorporating it into an automatically controlled cathodic protection system. The system has the approval of Lloyd's Register of Shipping.

SHORTER REPORTS

Radar for Port of London

EXPERIENCE of harbour radar at a number of major ports throughout the world has demonstrated both to shipowners and port authorities that such a system, in conjunction with the recently standardised marine V.H.F. communication frequencies, offers great advantages and economies both of time and money. The Thames Navigation Service is now being implemented in its preliminary stage, as illustrated, and the first harbour radar installation will be a Decca Harbour Radar, type 33, a contract for which has been placed by the Port of London Authority. The latter is building new harbour offices adjacent to the Royal Terrace Pier, on the south bank of the river at Gravesend. The building is designed round the "operations room," which will be an integrated port operating centre, collecting, sorting and providing to ships navigational information covering the whole river from The Nore to London Bridge. The scanner of the first radar will be mounted on the roof of the building and the display will provide in the operations room a detailed picture of the situation in Gravesend Reach, over some 5 miles of river.



Decca harbour radar at Gravesend

The operations room is designed so that, as a result of experience, further radar stations can be set up both above and below Gravesend, feeding additional displays. Eventually, if the demand necessitates, the entire river from the seaward limit of the port up to the Royal Docks will be shown on eight radar displays at one central position.

The choice of Gravesend for the first radar station means that the most critical section of the river will be the first to benefit. Through this area pass an average of eighty ships each way every twenty-four hours throughout the year, and, in addition, Gravesend is the port control point where customs and Port Health Authorities grant pratique and where sea and river pilots change over. The channel is 1000ft wide and, in addition, there are two entrances to Tilbury Docks, tug stations, ferries, the Tilbury landing stage and numerous other harbour activities. Ships also use the reach as an anchorage and it has become essential for the Port Authority to take steps to prevent undue congestion of shipping in this area during periods of low visibility.

The radar to be fitted is based on type 32, and is a high definition X-band equipment having an aerial reflector of parabolic section with a horizontal aperture of 6ft and a vertical aperture of 1ft 8in. This system provides a horizontal beam width of 1·2 deg. at half-power points with a vertical beam width of 20 deg. Within plus or minus 10 deg. of the main beam the side lobe level is better than 23 dB and is better than 30 dB outside this point. The aerial has a speed of 24 r.p.m. and to ensure continuous operation during maintenance there are two separate transmitters and receivers with remotely controlled changeover switching arrangements. The display is of Decca Fixed Coil pattern, having 15in long persistence fluoride tubes and with provision for off-centring.

The system will provide a comprehensive picture of shipping activity and the display of this information in the new centre will assist the staff, pilots and other river users in the efficient operation of the port. From the radar information available there should be enhanced economy in the operation of tugs since the authorities can forecast requirements and make allocations accordingly. Calls for assistance can be assessed and the necessary services organised while a steady flow of traffic can be maintained and costly delays, caused by ships anchoring in the fairways in bad visibility, avoided by the assistance of the shore radar. Furthermore, port maintenance can be more efficiently operated since the position of buoys, &c., can be checked by radar and should any be adrift warnings can be issued and recovery aided.

Belt Conveyor as a Controller

A NOTE has been received from the makers of Sandvik steel belt conveyors describing how a steel belt conveyor is used as a control device for the cutting stroke of a separating saw. At the works of the Mineral Wool Insulation Company, of California, U.S.A., mineral wool blankets are fed individually along a conveyor belt into a continuous wrapping machine. The blankets emerge on a conveyor belt as a continuous wrapped strip. The problem of cutting the wrapping between individual blankets of different length was overcome by installing a 1in wide Sandvik steel belt conveyor parallel with one side of the conveyor carrying the blankets through the machine. On the ingoing side of the machine a photocell is fitted and the beam to this cell, passing through the spaces between the individual blankets, actuates a solenoid. The solenoid moves a stop over the adjoining steel belt conveyor and each movement releases a small permanent magnet trip block. Each trip block adheres to and is carried along the steel belt conveyor at the same speed as the blankets are carried through the wrapping section of the machine on their conveyor.

At some distance along the outgoing side of the machine each trip block contacts a micro-switch that energises the cross feed of a saw which advances and cuts across the wrapping in the space left on the ingoing side of the machine between the blankets. The magnetic trip blocks are carried on round the return side of the steel belt conveyor to a storage line holding a number of blocks behind the solenoid-operated trip stop of the space detection unit on the ingoing side.

Forth Road Bridge

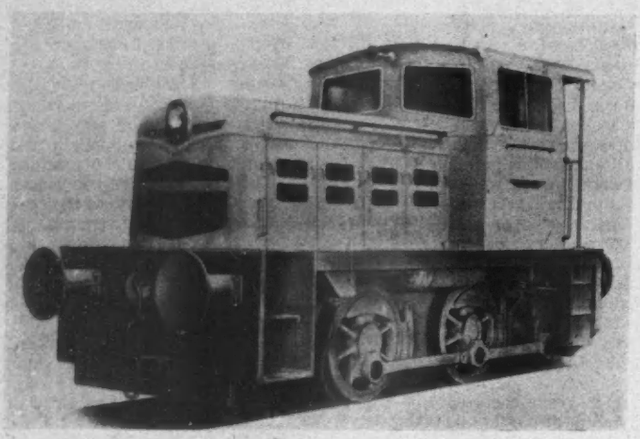
THE Forth Road Bridge Joint Board has placed a contract, valued at approximately £2,500,000, with John Howard and Co., Ltd., 13, Buckingham Gate, London, S.W.1, for the first phase of the new Forth road bridge. Work on the bridge will begin within a week or two with the construction of the foundations for the main piers of the bridge, including compressed air caisson work. The anchorages for the main cables will also be started on. These will require large tunnels, up to 40ft square, some 200ft into the rock. The reinforced concrete side towers will be about 150ft high, and their erection is part of the first phase, too. The bridge will have a span of 3300ft between the main piers, the largest clear span in the United Kingdom; it will be the largest suspension bridge in Europe and the fourth largest in the world. The consulting engineers for the scheme are Mott, Hay and Anderson, of London, and Freeman, Fox and Partners.

An artist's impression of the new Forth road bridge

Diesel Shunting Locomotive

A SERIES of trials has been completed successfully by the first model of a new range of diesel hydraulic-mechanical shunting locomotives introduced by John Fowler and Co. (Leeds), Ltd., Hunslet, Leeds, 10. These locomotives are a further development of those powered by Leyland 900 engines which were introduced by the firm last year and described in our issue of November 29, 1957. They have been developed in collaboration with the Self-Changing Gear Company, Ltd., and Leyland Motors, Ltd., and incorporate a single-stage Schneider torque converter. These converters are now being made under licence in this country by the Self-Changing Gear Company, Ltd.

The demonstration locomotive on which trials have been carried out under widely varying conditions in different industrial establishments is illustrated on this page. It is a 185 b.h.p., 0-4-0 locomotive, developing an initial starting tractive effort of 19,000 lb. The makers claim a number of advantages for the torque-converter form of transmission in that it gives simplicity of control ; stepless acceleration with no loss of tractive effort when changing gear ; good braking effect from engine and transmission when travelling down grade with a load ; precise control of



185 b.h.p. diesel shunting locomotive fitted with a single-stage torque converter and three-speed air-operated gearbox

wagon loads down to less than ½ m.p.h.; and economy in fuel consumption.

The leading dimensions and characteristics of the demonstration locomotive are : overall length (over buffers), 21ft ; height, 11ft 7in ; overall width, 8ft 6in ; and, with 3ft 6in diameter wheels, a wheelbase of 5ft 6in. It has a top speed of 12 m.p.h., with 30 tons adhesive weight. The power unit is a Leyland/Albion six-cylinder, normally aspirated, four-stroke engine, with a twelve-hour rating of 185 b.h.p. at 1600 r.p.m. From the single-stage torque converter the drive is taken through a cardan shaft to a " Wilson " three-speed, air-operated, epicyclic gearbox and then to an air-operated forward and reverse unit, embodied in which is the reduction gearing and the main jackshaft.

The single-stage torque converter fitted in the locomotive is capable of a 3 to 1 torque multiplication. In series with the torque converter is a heat exchanger and a service oil tank and filter.

Conveniently grouped driving controls duplicated each side of the cab include the engine throttle, air brake, gear change lever, forward and reverse control lever, sander control and whistle.

A central gauge and instrument panel is situated on the driving desk and a desk switch key is provided to prevent unauthorised operation. Forward and reverse indicator lights are fitted, together with safety devices which ensure shut down of the engine in event of excessive cooling water temperature, low lubricating oil pressure and excessive converter oil temperature. Straight air Westinghouse brake gear operates one block on each wheel, and air is supplied by a compressor driven by belt from an extension shaft at the front of the engine.

Careful attention has been given to provide all-round driver vision and at the rear of the cab there is a covered shunter's platform extending across the width of the locomotive. When working two locomotives in multiple operation, there is easy access from one cab to the other without the driver first having to descend to ground level.

We are informed that these hydraulic-mechanical locomotives can be supplied as single or tandem units in a power range of 185 to 460 b.h.p. with an 0-4-0 or 0-6-0 wheel arrangement, and for rail gauges between metre to 5ft 6in. The locomotives will cover a range of initial tractive efforts of from 18,000 lb up to 40,000 lb.

Jet Transport Projects

DETAILS are now available of two jet transports projected by Handley Page, Ltd., Cricklewood, London, N.W.2, the " H.P.111 " and the " H.P.113." The first is a very powerful aircraft on well-established principles, the second a small high-speed research jet-liner which is intended to demonstrate the practicability of the boundary layer control techniques in which the firm have shown such interest.

The military transport aircraft, derived from the " Victor " bomber, would be capable of fulfilling the tactical roles of parachute dropping and assault landing as well as long-range heavy transport. The use of a jet aircraft off and on to " semi-prepared " runways has led to great power—four Rolls-Royce " Conway " 11 by-pass jets of 17,250 lb sea level static thrust each—and to the specification of reverse thrust, flap blowing, and an undercarriage with a skid as well as twelve wheels, on each main leg. The wing and tail of the projected aircraft are for the most part identical with those of the " Victor," except that both have drooped leading edges and there are no leading edge flaps, but the wing is fitted low down on a 15ft 6in diameter circular fuselage which, despite a 9·6 lb per square inch pressure differential, has large doors under the near section.

The forward part of the fuselage, back to the main spars, consists of a flight deck and passenger cabin in the top half and a hold for heavy freight in front of the spars. From there back to the doors there is a hold 11ft 6in high and wide and 40ft long. The floor is in two parts, one fixed on the bottom of the hold and the other able either to rest on the first or be lifted by the freight hoists and form a separate upper deck. Thus, bulky freight or passengers can be carried on two levels, or heavy dense objects on a deep, strong floor at the lower level. The upper floor can be extended over the main doors by fitting easily handled sections. Rearward facing seats could accommodate 202 passengers at 34in pitch.

In the tactical role, loads could include tracked vehicles of up to 22 tons weight. Air dropping of loads up to 1 ton each can be performed from either upper or lower deck, and 120 paratroopers can be landed, jumping in four sticks simultaneously.

The aircraft will carry an " Artouste " auxiliary generator in the starboard wing root. The only auxiliary draw on the main engines will be constant-frequency alternating current. For flight above 35,000ft, at which level the " Artouste " can be started, stand-by alternators driven by ram-air turbines are provided.

That part of the structure derived from the bomber—i.e. the wing—has, of course, a limited fatigue life, probably 45,000 hours in long-range transport, 36,000 hours in short-range transport, and 18,000 hours in supply-dropping. The wing, we are advised, uses multiple loadpaths throughout to the extent of being " fail-safe," and cracks will be visible on inspection.

The gross weight of the aircraft will be 240,000 lb and the span 130ft over the wing-tip tanks ; this corresponds to a wing loading of 85 lb per square foot. The maximum payload of 53,000 lb would be carried 3300 nautical miles in still air : the maximum landing weight is 180,000 lb. At 200,000 lb the machine would cruise at 545 m.p.h. at 50,000ft.

For operation from semi-prepared runways, the weight is limited to 180,000 lb : the maximum payload can then be carried 500 nautical miles. Taking off from grass (the tyre contact pressure is reduced to 45 lb per square inch by the extensible skids), 50ft is reached in 3000ft in an ambient temperature of 40 deg. Cent. at a weight of 144,000 lb, or 152,000 lb using methanol injection. On wet grass, using flap blowing until touchdown, reverse thrust and a drag parachute, the ground run at maximum weight is only 2600ft.

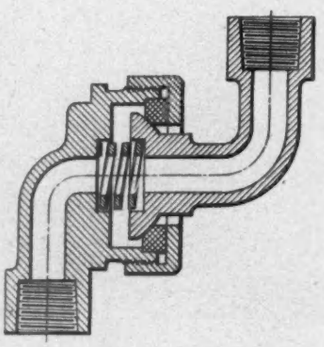
The sponsors believe that aircraft ordered now could be in service by the end of 1962.

The " H.P. 113," a small jet-liner which would serve to carry small numbers, up to twelve, of passengers over long distances, though, of course, not at commercial cost levels, is powered with two Bristol " Orpheus " jet engines slightly modified to allow four-stage auxiliary compressors in front of the engines to be driven at engine speed through mechanical clutches. These two relatively small engines—probably about 2 tons thrust each—will allow the aircraft to take off at 36,500 lb, with a payload of 2520 lb (the maximum) and fuel for 3640 miles with full allowances, or with 1000 lb payload and fuel for a 4330 mile stage. This performance would allow eleven passengers to fly from Lyneham to Woomera with only two stops in less than twenty-one hours. The contribution of boundary layer control is an increase of over 60 per cent on stage length, and of maximum range from 3870 to 6300 miles.

The aircraft has a superficial resemblance to other light jet transports such as the " Sabreliner," but the engines are within the rear fuselage with scoop intakes, and the tail-plane is mounted on top of the fin in the manner initiated by the " Victor " : the tail-plane moves but there are narrow elevators as well. The tail surfaces as well as the wing are laminarised, and only a narrow rudder is required. Boundary layer control is also applied in the form of flap-blowing : it is expected that the compressors would only be clutched in at altitudes above 20,000ft, while blowing would be confined to low speed and low altitude flight. The suction would be applied to narrow machined slots, but on the leading edges and access doors in the wing surfaces it takes place through the pores of sintered steel. The aircraft cruises at Mach 0·8, corresponding to 528 m.p.h., all long-range flights being carried out at about 40,000ft : the flight envelope is dictated by the same parameters as for a conventional aircraft, and it is not expected that suction will influence the maximum Mach number limitation. The ranges quoted assume that no precipitation will be encountered at operating altitudes.

Self-Sealing Swivel Joint for Pipes

THE construction of a self-sealing swivel joint for pipelines which is now being made by Hilyn Industrial Equipment, Ltd., Lockfield



Elbow pattern seal-sealing swivel joint for pipes

Avenue, Brimsdown, Middlesex, is shown in the accompanying drawing. It consists of a body with a pipeline connection in which a second connection can swivel through 360 deg. The second connection is retained in the body by a cap nut and has a part-spherical flange which bears against an annular P.T.F.E. sealing ring rigidly located by the cap nut. A spring held in compression between annular recesses in the body and swivel connection maintains an effective sealing pressure between the ring and the flange. In addition to allowing a full circle adjustment between the ends of pipelines, the mushroom shape of the connection flange is designed to allow up to 10 deg. sideways movement to provide for pipe misalignment.

The standard joints are made in elbow or straight patterns for pipes from ¼in to 2in B.S.P., and, if required, sizes up to 6in can be supplied. It is stated that in tests these joints have withstood pressures exceeding 2500 lb per square inch. For normal industrial applications they are suitable for pressures up to 500 lb per square inch and temperatures up to 485 deg. Fah. Normally, the component parts are made from gunmetal, but to special requirements they can be supplied in malleable iron, aluminium, or stainless steel.

"Diagrid" Floor for U.S. Embassy

A FLOOR of unusual design is being built by Wates, Ltd., the building and civil engineering contractors, in the new United States Embassy at Grosvenor Square, London. It is to be the first floor and will contain over 200 tons of steel. The full area for the main block and both wings will be patterned on the underside by diamond-shaped relief work in what is called "diagrid" construction, fashioned from precast units, 26in deep, U-shaped, and set at 7ft 9½in centres; the overall depth of the level is 42in, made up of 11in and 4in slabs and 31in and 38in projecting beams beneath.

The construction of this floor is being undertaken in three stages. First, the precast units are set out and placed, then the steel is fixed and the concrete poured. Next comes the placing and fixing of trunking for air-conditioning ventilation, heating, plumbing and electrical carcasing, including cork insulation for trunking. Then, with shuttering placed at the second slab soffit level, the steel is fixed and concrete poured for the floor slab proper.

At this level the perimeter of the building juts out from the lower external supports and the floor is cantilevered a distance of 7ft from the columns below, with a slab thickness of 11in all round the building.

The architects are Eero Saarinen and Associates, in association with Yorke, Rosenberg and Mardall. The consulting engineer is Felix J. Samuely.

The precast shell units are 26in high and 11in wide, and are here shown in position at 7ft 9½in centres

Aluminium Hatch Covers

IN recent years there has been an increasing interest in the possibilities of aluminium as a material for hatch covers, and the announcement that complete sets of welded aluminium MacGregor insulated 'tween deck covers are to be fitted in three Royal Mail Line ships, now being built at Belfast by Harland and Wolff, Ltd., comes as a result of development work and of successful service experience with existing installations. The structural design of these covers has been developed by MacGregor and Co., Ltd., in conjunction with Saunders-Roe (Anglesey), Ltd., who are fabricating them from materials supplied by Northern Aluminium Company, Ltd.

In hatch covers the weight saving made possible by the use of aluminium increases the cargo deadweight of the ship and facilitates handling. The corrosion resistance of the material and a consequent reduction in maintenance can also be taken into account, and all these factors together can more than outweigh the increased first cost of aluminium covers. A very good case for aluminium construction is also offered by the heavy insulated covers of refrigerated ships, the handling of which, particularly in the lower 'tween decks, can be a difficult operation.

Until the introduction into general use of the inert-gas consumable-electrode welding process, the development of aluminium covers was delayed by the impossibility of designing riveted structures to compete economically with welded steel structures. In 1954, however, the first aluminium MacGregor hatch covers were fitted experimentally in the ore carrier "Sunbrayton," built by the Burntisland Shipbuilding Company for Saguenay Terminals, Ltd. (now Saguenay Shipping, Ltd.) and although these were of riveted construction they have provided valuable service experience.

The "Sunbrayton," of 7850 tons deadweight is designed to carry bauxite from Mackenzie on the Demerara River, British Guiana, and has one hold served by five hatches fitted with single-pull MacGregor covers of which No. 1 and No. 5 hatches, of sizes 18ft by 20ft and 30ft by 50ft, respectively, have aluminium covers.

A full-scale prototype of a section of one of the "Sunbrayton" covers was tested to the satisfaction of the Ministry of Transport at Aluminium Laboratories, Ltd., Banbury, in 1954, in the presence of representatives from the Ministry and Lloyd's Register of Shipping. The cover was subjected in the test rig to a load of 8 cwt. per square foot without any sign of distress, and thereafter to almost twice that load without failure occurring.

Aluminium hatch covers as fitted to "Sunbrayton"

The scantlings of the covers thus tested had been selected on the basis that strength and deflection were to be comparable with the equivalent steel covers, and the same principle has been followed with later designs. On this basis the proportion of weight saved by using aluminium with welded construction is about 50 per cent.

The owners of the "Sunbrayton" report that after four years of rigorous service the aluminium covers are in very good condition, comparing favourably with the steel covers on the remaining hatches. This report is the more interesting since it was necessary to use the same type of standard steel fittings as for the steel covers. These were attached with steel rivets, a chromated packing being placed between the faying surfaces, and in no instance is there evidence of galvanic action on the surrounding aluminium plate.

Light Television Camera

WE learn from Marconi's Wireless Telegraph Company, Ltd., that its latest design of television camera channel* is under operational trial by the British Broadcasting Corporation at Riverside Studios. This camera channel, known as the Mark IV, is stated to be equally suitable for outside broadcasting and the studio. The design derives from the Mark III channel, which uses the 4½in image orthicon pick-up tube, and which has been adopted by television authorities throughout the world. The Mark IV camera weighs less than 100 lb. Advantage is thus taken of the technical merits of the 4½in tube, the maker claims, at a weight comparing favour-

* Fifteen of these camera channels were recently ordered by the B.B.C. for its new White City Television Centre, and the Australian Broadcasting Commission has also ordered eight for its new television studios at Brisbane and Hobart.

ably with that of cameras designed specifically to take only the 3in tube.

Twelve valves are used in the camera itself, and seven of these are the long-life close tolerance Mullard Type E88CC. The use of these valves, together with plug-in printed wiring sub-panels and improved circuit design, is said to have resulted in a more stable and uniform performance. The inherent stability is so high that the "electronics" of all the cameras in a studio can be controlled from one position.

The new features reported include an image orbiting device which is designed to prevent

This image orthicon camera channel, known as the Mark IV, is said to be equally suitable for outside broadcasting and studio. Weighing under 100 lb it is claimed to be the lightest camera in use incorporating a 4½in image orthicon pick-up tube. The picture shows the Mark IV in use at the B.B.C.'s Riverside studio

"sticking" on static pictures (thereby prolonging the useful life of the pick-up tube) and a new picture and waveform monitor with 14in picture and 5in waveform tubes. The camera control and power supply are arranged for rack or mobile mounting, and the control panel contains no valves. The compact printed wiring boards have two screened busbars running along the edges, providing low impedance H.T. points, earth points and heater supplies. These busbar systems add to the mechanical rigidity of the board and are used to provide a means of fixing. The circuits are carried on small printed sub-assemblies which are plugged into the main frame giving easy access for rapid maintenance.

The four-position lens turret is carried by a large diameter tube running in self-aligning bearings at back and front of the camera, with an indexing mechanism at the rear. A single turn of a handle on the right-hand side of the camera moves the turret one position, with a non-linear rotation which permits a heavy set of lenses to be accelerated from rest and smoothly halted. The indexing mechanism works silently. A turret position indicator is visible in the viewfinder hood. The lenses have the same type of flange and clamping as the Marconi Mark III but are mounted on an 8in diameter pitch circle. Any lens up to 40in focal length can be mounted opposite a 2in lens without interference. A hollow shaft permits turret mounted lenses of the "Studio Zoomar" type to be used; alternatively, the turret can be removed to accommodate the larger zoom lenses.

A 7in diagonal rectangular tube, recessed into the back of the camera, is used for the viewfinder. This is larger than that used in previous cameras and there is no need for magnifying lenses.

A new design of yoke of somewhat smaller diameter and lighter weight has been used. The yoke carriage slides on self-aligning P.T.F.E. bearings running on chromium-plated guides, giving very low static friction and wear. A simple focusing mechanism is provided, operated from a three-spoke capstan wheel on the right-hand side of the camera, giving approximately two turns for full travel.

A 4½in image orthicon pick-up tube manufactured by the English Electric Valve Company, Ltd., is being used in the camera during the current B.B.C. trials.

Reorganisation of Steam Services

As part of a reorganisation of steam services a new central boiler house has been built at the Nightingale Road Works of Rolls-Royce, Ltd.

This centralisation of steam generation plant permitted the closure of two boiler houses which contained ten boilers of the oil-fired Lancashire and locomotive design. The steam generated is provided to meet the process and space heating requirements of machine shops, plating shops, &c.

The main contract for the erection of the new boiler house building and the new boilers and auxiliary equipment, was awarded to Danks of Netherton, Ltd., while the architects were J. Seymour Harris and Partners.

The boiler house building is 97ft 8in long by 40ft wide and 26ft high to the ridge, and is of steel portal frame construction with patent glazing extending from 10ft above floor level, and the roof is constructed of galvanised steel decking covered with ½in thick insulation board and mineral surfaced felt. Ventilation is provided by a continuous ridge type ventilator. The boiler house is cool in summer and is adequately ventilated all the year round, and the portal frame construction made it possible to reduce the height of the building.

The chimney is 120ft high with an internal diameter of 6ft.

As will be seen from the illustration the new boiler installation consists of five 11ft diameter Danks of Netherton super-economic "Contraflo" boilers constructed with safety valves set to blow off at 105 lb per square inch. Each boiler has a steam output of 14,000 lb per hour from feed water at 170 deg. Fah. when burning fuel oil having a viscosity of 950 or 3500 seconds Redwood No. 1 at 100 deg. Fah. All boiler operating valves have been fitted towards the rear and are accessible from the cat walk running along the top of the boilers. The feed water mains have been arranged in trenches which run the full length of the boiler house. The boilers are lagged with "Fibreglass" 2in thick on high plates, 2½in thick on low plates, supported by 1in meshwire netting and finished with ½in of hard setting compound.

Three main oil storage tanks are provided, each 18ft in diameter by 20ft high, and having a total nominal capacity of 440 tons. The tanks are unlagged, and are provided with steam coils for normal operation, and electric outflow heaters for starting up operations. Each boiler is equipped with Clyde pressure jet oil burning equipment which operates under induced draught. The oil pumping and heating unit consists of two steam-heated oil heaters together with an 18kW Dunlow electric oil preheater which is only used for starting up.

There is a 5000 gallon capacity mild steel feed water tank protected internally by Apexior No. 1. The admission of cold make up water is controlled by a Mobrey magnetic level switch which operates a motorised valve in the softened water main. Two Weir vertical single cylinder double acting feed pumps are installed and the exhaust steam from the feed pumps is passed through a copper coil in the boiler feed tank. Each boiler is provided with a Ronald Trist "Thermofeed" control together with the automatic regulating valve in the feed water line and a control valve in the auxiliary steam line. Ronald Trist "Mobrey" low water alarms are also fitted to each boiler.

All make up water which is approximately 25 per cent of total boiler output is passed through a base exchange softener supplied by Feedwater Specialists Company, Ltd., of Liverpool. This softener is capable of dealing with a maximum flow rate of 5000 gallons per hour, and with Derby Towns water can soften a total of 80,000 gallons between regenerations. An adjunct treatment consisting of selected tannins, Calgon and caustic soda is also provided. A number of safety controls have been installed, and include :—Flame failure equipment which operates a magnetic valve in the fuel oil line, to shut off fuel supplies should a failure occur; a "Mobrey" low water alarm which operates a magnetic valve in the fuel oil supply line; and Igranic flow switches in the cooling water circuit to each i.d. fan, so that should the cooling water flow be restricted these flow switches will automatically shut down the fan and the oil burning equipment on the particular boiler.

The new boiler plant has achieved a considerable reduction in fuel and labour costs. During the summer period, when no space heating steam

Boiler house at Rolls-Royce works, Derby

is used, the installation has resulted in the weekly fuel oil consumption falling from 80 to 60 tons per week. In addition, whereas the maximum fuel oil consumption on the new installation has been of the order of 215 tons per week during the most severe winter weather, the maximum consumption with the old plant was of the order of 315 tons per week.

The annual fuel consumption of the site from 1954 onwards was as follows : (prior to installation of new boilers) : 1954, 8969 tons ; 1955, 8994 tons ; 1956, 8946 tons—(boiler plant completed December 31, 1956) : 1957, 6495 tons.

It will be seen that although the weather in 1957 was comparatively mild compared with previous years, there has been a considerable reduction in fuel consumption.

An estimate of the fuel saving made, based upon "Degree Days" calculation, indicates that approximately 1700 tons of fuel oil of the 2500 tons actually saved was mainly attributable to the increased efficiency brought about by the new plant. As the average price of fuel oil during 1957 was more than £12 per ton, the financial savings over this period of twelve months amounted to over £20,000. In addition to the financial saving resulting from the reduction in the fuel oil used, a further £2000 per annum in labour costs has been saved by operating one central boiler house instead of two smaller units.

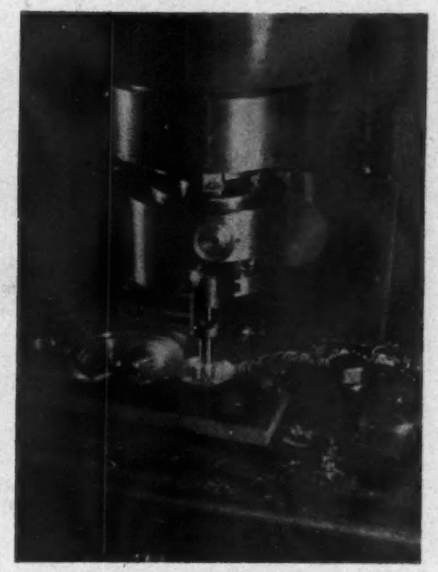
The exit gas temperatures from the boilers are always maintained at 400 deg. to 450 deg. Fah. at all loads from 60 to 110 per cent of the boiler rating. CO_2 readings of between 11 to 13 per cent can be maintained without any difficulty at loads between 60 and 100 per cent of the boiler ratings. Although normally rated at 14,000 lb per hour, the boilers have been operated for test periods at outputs of over 15,000 lb per hour.

Boring and Facing Head

THE accompanying illustration shows a new tool developed by the Swindon Tool Company, Ltd., Trading Estate, Cheyne Manor, Swindon, which can be used as a normal adjustable boring head, or for repetition facing or undercutting operations. The slide on which the boring tool holder is mounted in the head is actuated by a self-contained, spring-loaded, hydraulically controlled system. Through this system the cutting tool slide is moved outwards whilst the head rotates to face or undercut work until a preset stop is encountered. The tool slide has a travel of 2¼in across the head, and when an angular tool setting in the holder is used the head has a maximum facing capacity of 9in diameter. Interchangeable taper shanks can be provided to enable a head to be used on a number of different machines in a workshop if necessary.

Referring to the illustration, the larger of the two dials to be seen on the body side is the micrometer stop used in facing operations to control the length of slide traverse and thus diameter of cut. This dial is graduated in increments of 0·002in. The smaller dial is the normal slide setting micrometer screw, which is disengaged during facing operations by movement of a small locking lever on the face of the body. A jib locking screw is fitted in the head on the opposite side of the slide to the micrometer screw.

Projecting from the upper and lower faces of the body are two square nuts, which may be operated by a spanner to return the tool slide to its inner setting for facing work. As either of these nuts is turned a load is imparted to a spring which develops a pressure of some 140 lb per square inch in the cylinder of a closed hydraulic system when the slide has reached its innermost setting. The slide is coupled to the piston-rod of the hydraulic cylinder, and the speed of its movement outwards during the facing stroke is controlled by the opening of a needle valve, through which the pressure fluid passes from one side of the piston to the other. A graduated knob on the lower face of the body is used to set the needle valve opening. The hydraulic system is maintained under a constant pressure and normally it only needs topping up after a tool has been in constant use for six to eight weeks. When the tool is being used as a normal boring head the control valve is kept open and the internal



Automatic boring and facing head with a tool holder slide actuated by integral hydraulic pressure system

hydraulic pressure serves to take up any backlash in the slide.

In the normal facing operation from a hole the slide is first centred in the head and the feed control valve closed. The main machine slide is then used to set the tool to the required depth of facing cut and the control valve opened to allow the slide to move outwards till the cutter tip just contacts the side of the bore on the workpiece. The valve is then closed to stop further slide movement, and the micrometer stop disc is turned anti-clockwise (one turn per 0·100in diameter on face) to the required face diameter. After the slide has then been wound back a short distance for the tool tip o clear the bore side, the control valve is opened to start slide cross feed as the machine spindle is started. The head slide continues to move outwards to carry the tool over the face until its movement is halted by the micrometer stop. Repeat cuts can be taken by winding the slide back with the machine stopped between cycles, without any need for further settings to the micrometer stop or control valve. Workpieces can be undercut or recessed using the same procedure.

A.W.R.E. Research Reactors

As announced on page 106 of THE ENGINEER for July 18, the Atomic Weapons Research Establishment at Aldermaston is equipping itself with research reactors to be called "Horace" and "Herald." These were very briefly described in our report, but more information has now become available.

"Horace" became critical on May 7 and is an experimental reactor in which various arrangements of fuel and reflector elements may be tested for "Herald." The core is moderated, cooled and shielded by ordinary water in a 12ft diameter tank sunk 15ft below ground. Dummies of neutron-beam tubes and sections of the graphite thermal column, lead shields, &c., simulate the equipment of "Herald," and so help to give a representation of the neutron flux pattern that will be obtained in the later reactor. The power is restricted to about 10W. This output is low enough to be dissipated by natural convection, while the flux density reached is sufficiently high for measurements of neutron flux distributions to be made easily by foil activation techniques. Suitable means of controlling water temperatures are included which allow certain coefficients of reactivity important in the evaluation of safety to be measured. For example, the change of reactivity per unit rise of temperature of water between fuel plates, with water temperature constant outside the fuel elements, is being measured for a typical core. It has been demonstrated that this temperature coefficient has a most desirable large negative value (about 0·012 per cent per deg. Cent.) over the range of temperature 17 deg. to 35 deg. Cent., and this temperature range is being extended to 65 deg. Cent. Core loadings with different arrangements of fuel and reflectors are being tried in order that the best fast and thermal neutron fluxes may be obtained at the experimental ports in "Herald." The effectiveness of control absorbers is being examined. The reactor is also being used to train staff who will use and operate "Herald." The well occupied by "Horace" will eventually become the store for used fuel from "Herald."

"Herald" itself will use highly enriched uranium fuel and operate at 5MW. It is being built by the A.E.I.–John Thompson Nuclear Energy Company, Ltd., and is in fact an adaptation of that company's "Merlin" design* to an A.W.R.E. specification. We understand that the need for a versatile research reactor at A.W.R.E. has been acute for some time. The basic requirements are for a reactor to provide (*a*) intense beams of thermal and epithermal neutrons, and (*b*) high neutron flux for irradiating small samples used in radio-chemical research. "Herald," moderated by ordinary water, will also afford a very high flux of fast neutrons for the study of radiation damage.

Clearly certain applications of the reactor will be associated with atomic weapons and therefore secret. However, some uses have been described. For example, activation analysis will be used instead of present chemical analysis of materials. A flux of 10^{12} n/cm²sec. makes it possible to detect as little as 10^{-6} μg of certain elements. Radiochemical studies of short-lived nuclides produced in neutron-induced fission of various isotopes will be possible. Production of certain short-lived radioactive isotopes will benefit a number of researches in the Establishment. Time-of-flight techniques will be used to measure various total and partial neutron reaction cross sections as a function of neutron energy in the range from thermal to 100keV. A fast neutron chopper of high resolution, and associated evacuated flight tube and detector stations, are now being built for this purpose. The reactor will also provide "health physicists" with suitable sources of neutrons or γ-rays for calibration of instruments and tests of shielding. Some of these types of work have hitherto been done on "Bepo" and "Dido" at Harwell.

"Herald" is scheduled for completion in December 1958. A probable initial core arrangement will be a 7 by 4 array of fuel elements. The fuel elements are plates of U, Al alloy, generally similar to those used in "Dido," "Pluto," the Dounreay materials testing reactor, and "Merlin." The uranium to be used is enriched, and each element will contain 161 g of U^{235}. Reactivity is to be controlled by means of four cadmium sheets clad in stainless steel. A coarse-control and two shut-down absorbers will each govern about 5·5 per cent reactivity, and a single fine-control absorber will govern about 0·5 per cent. Each neutron-absorbent sheet is to be moved by an electric motor through a rack and pinion. The motors are to be mounted above the structure of the core. The core and control gear will be movable vertically to any of three positions. The central position is in line with the experimental ports and the thermal column ; the upper position is convenient for changing fuel elements, and the lower position is for safety when the reactor is shut down.

The aluminium tank containing the reactor is 5½ft in diameter, widening to 11½ft in diameter at the open top. The height of the tank is 30ft overall. A 4in thickness of lead around the tank provides the thermal shield, and 6ft of concrete provide the biological shield. The water is pumped down through the core then through a 100-second delay tank to an air-cooled radiator and back to the top of the core.

Experimental facilities in "Herald" will include one 10in and four 6in diameter neutron beam tubes terminating at the core, two 6in tubes which run past the edge of the core, and a horizontal thermal column traversed by two 6in tubes. The maximum fluxes in the tubes at a

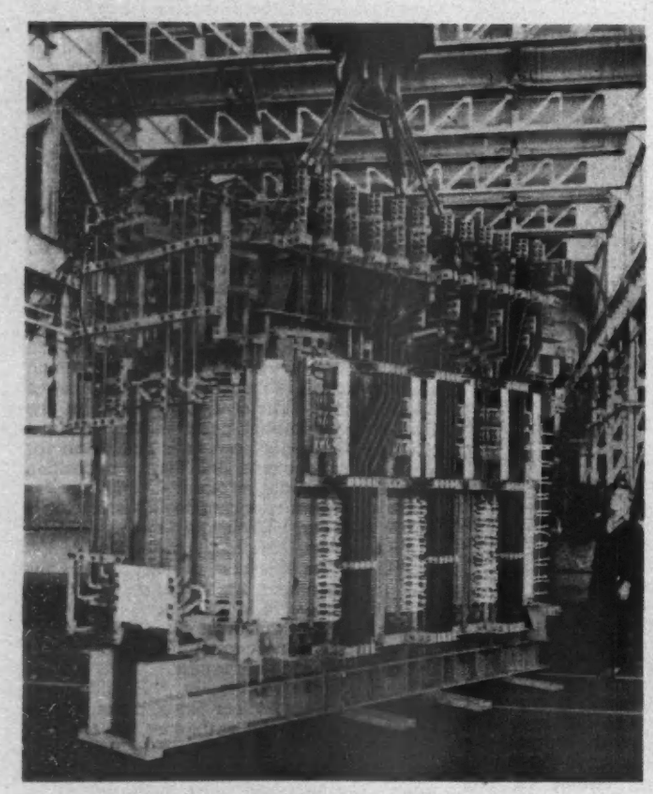
* See THE ENGINEER, August 19, 1955, page 262.

reactor power of 5MW are expected to be 2×10^{13} n/cm²sec. thermal, 10^{12} epithermal and 10^{8} röntgen per hour of γ-rays. There are to be two pneumatic self-service rabbit tubes delivering radioactive samples directly from the reactor to adjacent radiochemical laboratories (within fifteen seconds).

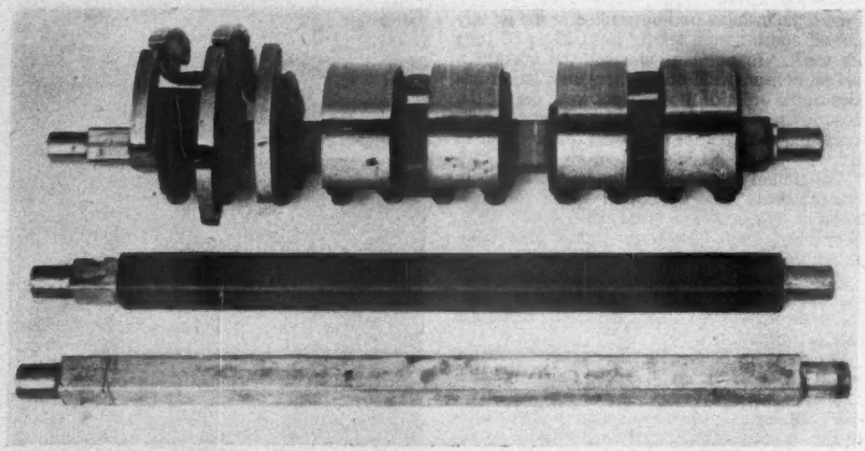
Power Plant for Canadian Aluminium Smelter

In an article entitled "Aluminium Smelter Plant at Baie Comeau, Canada" which was printed in our issue of February 7 of this year, brief mention was made of the equipment supplied by the British Thomson-Houston Company, Ltd. This company was responsible for the design, manufacture and installation of the complete power conversion plant, consisting of transformers, rectifiers, switchgear and ancillary equipment for Stages 1 and 2. Stage 1 of the smelter which is being built for Canadian British Aluminium Company, Ltd., a subsidiary of the British Aluminium Company, Ltd., was completed in December of last year, and the first metal poured. Each pot line, consisting of vertical stub pattern Soderberg furnaces, requires 100,000A at 850V d.c. and since the smelting process is continuous it is essential that the electrical supply is always available. To ensure this, the design of the plant provides for the removal, for inspection or maintenance purposes, of any part of the plant without reduction in power. Thus any seven of the eight conversion units can maintain the full output required from the pot line.

Each unit consists of a single rectifier transformer, illustrated herewith, and rated at 12,100kW, 850V d.c., coupled to a bank of eighteen truck-mounted cubicle-enclosed pumpless steel-tank mercury arc rectifiers, this form of enclosure giving a high standard of protection and also providing excellent accessibility to a degree, it is claimed, not generally encountered in Canada for equipment of this size. Apart from the question of size, the transformers are of interesting design and incorporate, as part of the main assembly, a phase-shifting transformer which enables 48-phase overall operation to be achieved with eight units in service. The company was responsible for the 33kV switchgear and standby circuits and for the 13·2kV system, for works distribution supply, together with certain low tension switchgear. The a.c. side of the transformers in the outdoor switchyard is controlled by 1500MVA oil circuit breakers while shelf mounted high-speed circuit breakers protect the d.c. side.



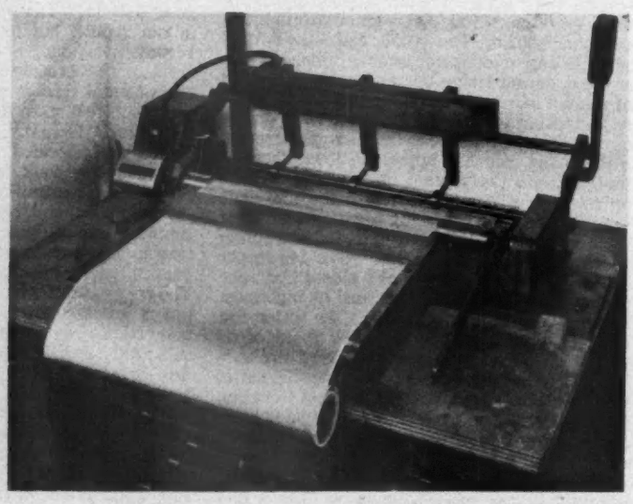
One of sixteen rectifier transformers rated at 12,100kW



(Top) Assembled switch drum. (Centre) Shaft insulated with glass cloth wrapping impregnated with an epoxy resin which acts as an adhesive under heat and pressure. (Bottom) Shaft before insulation

Shaft Insulation for Traction Motor Reverser Switches

The accompanying illustrations show an improved method of insulating the shaft on a traction motor reverser switch. This system has been developed by London Transport's mechanical engineering department at Acton Works. The mechanism used in the traction motor reverser switch is a rotating drum (illustrated above) with contacts clamped to a square central shaft insulated for 600V. Failures caused by loose clamping after shrinkage of the micafolium and shellac insulation in current use, prompted investigation into other methods of insulating the shafts. Early experiments in applying the micafolium to the shaft in the normal way with a hot iron, but using a bakelised cement instead of shellac for the final application, proved unsuccessful, and shrinkage still occurred. It was then decided to discard the micafolium as the main insulating medium, and a composition of synthetic resin and mica dust was developed for application to the shaft in a specially prepared mould. The trial shafts were given a final coating of anti-tracking paint and the contacts were clamped directly on the moulded insulation. This system proved satisfactory, both in mechanical strength and insulating properties, but difficulties in handling the compound retarded the production rate; it has also been shown from experience to be too hard to ensure that the contact clamps would grip and remain tight. These exploratory stages in the development were therefore quickly followed by further experiments using insulation in the form of a glass cloth wrapper, impregnated with an epoxy resin which acts as an adhesive under heat and pressure. The glass cloth was obtained in roll form to suit the full width of the shaft, and thirteen turns were wrapped by hand on the trial shafts. After successful tests it was then necessary to evolve a method of speeding up the process, and a special fixture (illustrated here) was manufactured for the purpose. The glass cloth is fed under tension on to the shaft which is rotated by a hand-operated ratchet device. As the shaft rotates the heat and pressure required to activate the adhesive is applied by a hand-operated, electrically heated press head. When the desired number of turns are indicated on the counter attachment the glass cloth is cut and sealed. The insulated shaft is then pressed between angle formers to ensure accurate dimensions, and placed in an oven to cure the epoxy resin. Finally, a coating of anti-tracking paint is applied to finish. This form of insulation has proved most successful under severe service conditions.



Fixture for applying glass cloth insulation. The heater press is raised. The heater regulator and turn counter are on the left

Industrial and Labour Notes

Engineering Wages

At the annual conference, last week, of the Confederation of Shipbuilding and Engineering Unions, a resolution was passed expressing approval of the wage claims which are awaiting the replies of the engineering and shipbuilding employers' federations. The claims were lodged some weeks ago following resolutions passed at the annual conferences of the Amalgamated Engineering Union and of other unions whose members are employed in the engineering and shipbuilding industries. During the union confederation's debate on wages last week, it was urged that there should be support for any action needed to bring the current claims to a satisfactory conclusion.

In his presidential address to the conference, Mr. H. G. Brotherton commented on the "niggardly attitude" of the employers' federations. One of the arguments against wage claims, he said, was that it was increased wages which were primarily responsible for rising prices. But, he declared, in the engineering industry labour costs per unit of output had risen by substantially less than the increase in prices. Labour costs per unit, Mr. Brotherton asserted, were no more than double what they were in prewar days, yet the prices of engineering products were on average more than three times the prewar level. Labour costs per unit had risen much less than the increase in retail prices for normal household expenditure. Mr. Brotherton went on to say that in his opinion the fall in the standards of engineering workers because of the rise in living costs increased the danger of a new industrial depression. Prosperity could not be maintained on the basis of a fall in the real purchasing power of the people.

Trade with the Soviet Bloc and China

At the end of last week, the Board of Trade issued a revised list of the products which are subject to embargo in the United Kingdom's export trade with the Soviet bloc and China. This list shows considerable relaxation of the embargo.

The Board of Trade has pointed out that the value of this country's "East-West" trade reached £214 million last year, of which imports were worth £124 million, and exports, including re-exports, £90,000,000. Nevertheless, this trade in 1957 still accounted for less than 3 per cent of our total foreign trade, compared with about 7 per cent in the immediate prewar years. The prospects for further expansion of this East-West trade have to be considered in the light of the fact that the foreign trade of the eastern countries concerned is in the hands of state monopolies and, as the Board of Trade puts it, "is conducted by them in accordance with predetermined but unpublished plans." In these circumstances, it is not possible for traders to employ normal methods of sales promotion in these markets, nor can the Government offer services to exporters which are as comprehensive as those normally available. But, as far as possible, the normal facilities are offered, including the facilities of the Export Credits Guarantee Department. The Board of Trade adds that it is very difficult to assess the prospects for trade in any particular commodity except by direct approach to either the appropriate state trading organisations in the countries concerned or their representatives in London.

In addition to facilitating such contacts by traders, the British Government gives publicity to trade possibilities in "Eastern" markets when the opportunity arises and it appears useful to do so. Assistance is also given to facilitate trade visits to and from these countries, and the help of the British embassies in their capitals is available to visiting business men. Inquiries should be addressed to the Commercial Relations and Exports Department, Board of Trade, Horse Guards Avenue, London, S.W.1.

Iron and Steel

There was little change in July in the present trend of British iron and steel production. Pig iron output averaged 227,000 tons a week, compared with 263,400 tons in July last year, and steel output was 315,900 tons a week, compared with 362,500 tons in the corresponding period of 1957. The Iron and Steel Board says there has been some decline in home steel consumption from the level reached in the autumn of last year. The effect on output has been considerably aggravated by consumers and steel producers both drawing on their stocks and by a decline in exports.

The Board has also stated that, in the second quarter of this year, total deliveries of finished steel by British producers were 8 per cent lower than in the comparable period of 1957. Home deliveries were 5 per cent lower and export deliveries 24 per cent lower. It will be recalled that in the second half of last year home consumption of steel increased with the revival of motor-car manufacturing and the continued high level of activity in the engineering industries. Since then, however, consumption has tended to decline and in the second quarter of this year was at about the same level as in the comparable quarter of 1957. But the decline in home deliveries compared with last year is very largely due to a reduction in consumers' stocks. Steel deliveries to coal mining and the railways during the second quarter of this year were lower than a year earlier, as were deliveries to industries manufacturing intermediate products such as wire, bolts, nuts and rivets. Nevertheless, deliveries to the motor vehicle industry and to electrical engineering continue at levels which are higher than a year ago.

Orders for Underground Trains

The British Transport Commission has approved the placing of orders by London Transport for seventy-six seven-car trains for the Piccadilly Line at a cost of £10,120,000. The main orders have already been placed and the trains will be delivered between the autumn of 1959 and mid-1962. This will mean complete replacement of rolling stock on the Piccadilly Line except for fifteen modern trains now in service and the three prototype "silver" trains which have been running on the Piccadilly Line for some months. As with the prototypes, the design of the new trains incorporates details first introduced in the 1938 tube stock. The major changes from the 1938 stock are the use of rubber for the bogie bolster and axlebox suspension; the use of fluorescent lighting, and the panelling of the cars in unpainted aluminium alloy sheeting. The placing of control equipment underneath the floor gives about 15 per cent increased passenger capacity compared with the stock now being replaced. Other features of the new trains which have been incorporated after trial on the three prototypes are a better arrangement of transverse seats in the centre bay, improved retractable shoegear, a modified electro-pneumatic brake system designed to ease maintenance and improve reliability, and a roller blind destination indicator above the centre cab doorway, illuminated by a fluorescent lamp. Fluorescent lighting also illuminates the train number plate cabinet. A new motor generator, incorporating a separate alternator to feed the fluorescent lighting circuits, has been designed to eliminate the undesirable noise associated with the machines fitted on the prototype trains.

For the Central Line, an order is to be placed shortly for twelve prototype motor-cars with under-floor equipment, each bogie having two motored axles. Their design will be the result of a special study now being made to determine the most satisfactory form of tube car construction and equipment for this particular service. The twelve motor-cars will be used with twelve rebuilt trailer cars to make up three eight-car trains for trial purposes. If the trials are successful, it is intended to equip the Central Line with trains of similar formation to the prototypes—that is, made up of new motor-cars and rebuilt trailer cars in equal numbers. This, it is stated, will speed up the re-equipment of the Central Line by reducing the number of new cars to be built.

The principal contractors for the Piccadilly Line trains are: Metropolitan-Cammell Carriage and Wagon Company, Ltd.; British Thomson-Houston Company, Ltd.; General Electric Company, Ltd.; Westinghouse Brake and Signal Company, Ltd.; Metropolitan-Vickers Electrical Company, Ltd.; G. D. Peters and Co., Ltd.; Associated Equipment Company, Ltd.; Hoffmann Manufacturing Company, Ltd.; Clifford and Snell, Ltd.; Peto and Radford, Ltd.; Patent Lighting Company, Ltd., and Benjamin Electric Ltd.

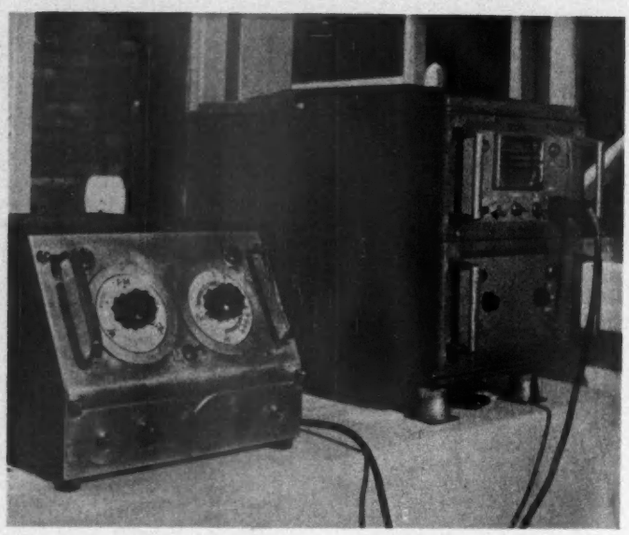
Agricultural Machinery Exports

The Agricultural Engineers' Association says that, although the first six months of this year was a "record breaking" period for the export of British tractors and agricultural machinery, the rate slowed down a little during June. The principal cause of this was undoubtedly the strike in the London docks. Some manufacturers have reported outstanding increases over their last year's figures, exports of planting machinery, for example, being as much as 90 per cent higher than a year ago. During June, overseas sales of combine-harvesters were 30 per cent above last year's monthly average and tractor exports were 5 per cent higher. The Association's comment is that "this compares well with the average 3 per cent rate of export increase for the whole engineering industry."

The official figures of tractor exports in 1957, which have recently been published, show that Britain exported nearly one and a half times as many tractors as the combined totals of the U.S.A. and Germany. German exports last year were 38,000 tractors, the U.S.A. 40,000 tractors, and the United Kingdom a record figure of 115,000 tractors.

French Railways Electronics Exhibition

An exhibition was held in June by the Société Nationale des Chemins de Fer Français, showing the progress which has been made in applying electronic techniques to signalling, train control and other departments of railway operation, including research. The exhibition was open to managerial grades and engineers from railway authorities belonging to the Union Internationale des Chemins de Fer.



DURING the second half of June, the Société Nationale Des Chemins de Fer Français held an exhibition, for managers and engineers associated with the International Union of Railways (U.I.C.), to show the progress which has been made in applying electronics and telecommunication engineering to railway operation. The exhibition was confined to equipment specially designed for railway use ; other apparatus, such as electronic calculating machines, which is of more universal application, was excluded.

The equipment shown was of a very diverse nature. Some items are actually in current use on certain French lines ; these included several track circuits of novel design as used in modern signalling techniques, various kinds of equipment for remote control, transmitter-receivers for radio telephony, and closed-circuit television for the observation of level crossings.

Other kinds of instruments are for measurement and research purposes. The fields which are of interest here include, among others, the structural resistance of rolling stock, soundproofing, stability and riding comfort.

Telecommunications.—Following successful tests on the electric line Valenciennes-Thionville in 1955, the S.N.C.F. decided to introduce telephonic communication between certain trains on the line Paris-Lille and the French and foreign telephone systems. Four trains will, in the first instance, be equipped with radio-telephony. Eleven stations along the line will be fitted with transmitter-receivers ; these will be spaced at such intervals—20km to 25km—that the ranges of neighbouring stations overlap. Each train will have a transmitter-receiver and a telephone cubicle. The stationary posts will be connected to the repeater station at the Gare du Nord at Paris, where the connection with the French telephone network will be made at the "Roquette" telephone exchange.

Another item on show was a lightweight portable transmitter-receiver for communication over short distances. Weighing only 2 kg, the transistorised equipment is designed for metre-wavelengths and frequency modulation. Such short-distance telephony has a great many uses in railway work, e.g. in shunting, train assembly, the testing of brakes, and other inspection work.

Level Crossing Control by Television.—The S.N.C.F. uses a specially adapted Thomson-Houston "Model THV 120" television set on the Paris suburban line Nogent-le-Perreux to Champigny for the remote operation of level crossing gates controlling two tracks. The equipment comprises three principal parts : a television camera fitted with "Vidicon" tube, a control box-receiver, and a special multi-core cable. The camera is mounted out of doors near the crossing. It measures 220mm by 220mm by 320mm, weighs 12 kg, and has a wide-angle lens with remote-controlled aperture, automatic control of sensitivity, and an industrial-type mounting with horizontal and vertical slewing. The camera is ventilated by means of an electric fan with dust filter ; if necessary, an electric heater can be fitted. The tube can be moved under remote control relatively to the lens in order to focus it. Transmission standard is 625 lines and fifty frames per second. Besides the "Vidicon" tube and its coils, the camera contains the video preamplifier, mounted on an anti-microphonic chassis, the video amplifier, synchronisation and sweep signal generator and signal mixer.

The control box is 170mm high, 240mm wide and 440mm deep and weighs 17 kg. It contains the controls for amplification, intensity, anode voltage, and polarisation and telephonic connection with the camera. These items are not used during normal operation and are mounted behind a cover. The remaining controls are an on-off switch ; a four-way switch with the following positions : waiting in winter (fan and heater on), waiting in summer (fan only on), stand-by (fan and filament voltage on), service (fan and all voltages on) ; manual or automatic control of sensitivity ; remote control of position and angle (not in use in the present case).

Connection between camera and control unit is made by means of a 420m-long special cable. This length could be increased to 1000m. The cable comprises a coaxial core, consisting of a centre and two mutually insulated screens, together with fifteen peripheral conductors. The receiver is equipped with a 36cm diameter cathode-ray tube, giving an image measuring 290mm by 220mm. It weighs 20 kg, measures 390mm by 360mm by 480mm and has an on-off switch and controls for focus, brightness and contrast.

In order to safeguard the camera against light when not in use, the lens, during waiting periods, is automatically occluded by an electromagnetic shutter. The automatic sensitivity control operates by changing the anode voltage of the image tube and compensates for light variation between 200 lux (late evening) and 20–30,000 lux (noon of a sunny day).

Track Circuits.—Four kinds of track circuit were shown, viz. a circuit operating on audio frequencies of 300 to 850 c/s ; a thyratron circuit operating with high-tension impulses ; a contactless circuit using 8700 c/s, and a track circuit with electrical contact.

The motive for developing the first-mentioned design was the rise of industrial frequency traction which made it impossible to use a frequency of 50 c/s in the circuits for automatic block control. The problem was provisionally solved by using single rail d.c. circuit on sections not affected by stray currents. Later, alternating current of 83·3 c/s was used, and eventually the use of audio frequencies was introduced and this was soon generally adopted. The new installations, by comparison with 83·3 c/s, save one-third of the installation costs as rotary converters and special feeders for 83·3 c/s are not required, the power consumption is three times smaller, and there is the possibility of later introducing the remote control of locomotives. The system is unaffected by stray currents.

Use is made of four frequencies, either pulsed or not. This avoids the possibility of accidental excitation by burned isolating joints, as the sections on either side of a joint operate neces-

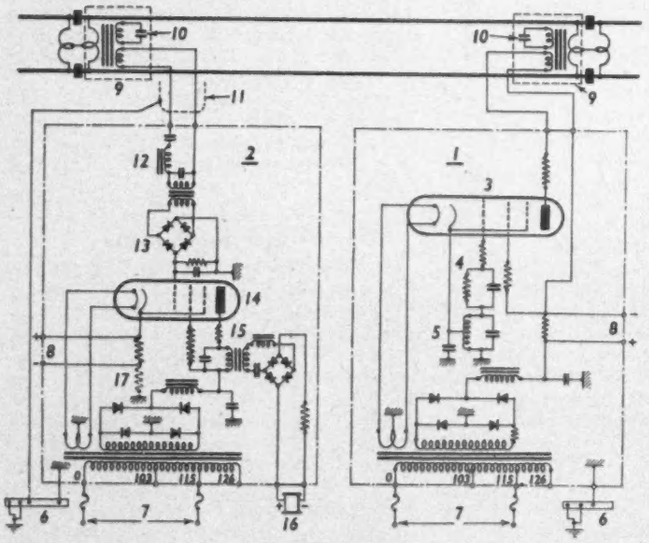


Fig. 1—Track circuit for 850 and 300 cycles per second

sarily at different frequencies. The frequencies actually in use are 300 and 850 c/s pulsed fourteen and twenty times per second respectively, and 2000 and 1500 c/s not pulsed. In order to preclude malfunctioning due to large fluctuations in the insulation of the ballast, or parasitic voltages between the rails due to an unbalance of the traction current and its harmonics, it is necessary to stabilise the frequency.

This kind of circuit is shown in Fig. 1. A transmitter comprises a long-life pentode oscillator, with grid-cathode coupling. A system of condensers and resistances in the grid circuit periodically blocks the 850 and 300 c/s oscillations, while those of 2000 and 1500 c/s are not blocked. The oscillations are transmitted to the rail by means of a tuned inductance.

On the receiver side, the energy is picked up by a similar tuned circuit and, after passing through a band-pass filter and rectifier, is finally fed to a relay which operates the signal. For 850 and 300 c/s, but not for 2000 and 1500 c/s, a pentode amplification stage is employed. The latter kind of receiver can be replugged for either frequency. Not having any valves, it does not require an external source of current; the other types are arranged for mains supply, with the possibility of employing an accumulator battery and converter as a standby in case of mains failure.

The circuits with 800 and 350 c/s can extend over up to 1500m of track, while those operating on the higher frequencies are limited to 400m. Fractured rails and burned joints are indicated when the line is clear. Maintenance is almost entirely confined to the replacement of valves which have a guaranteed life of 4000 hours.

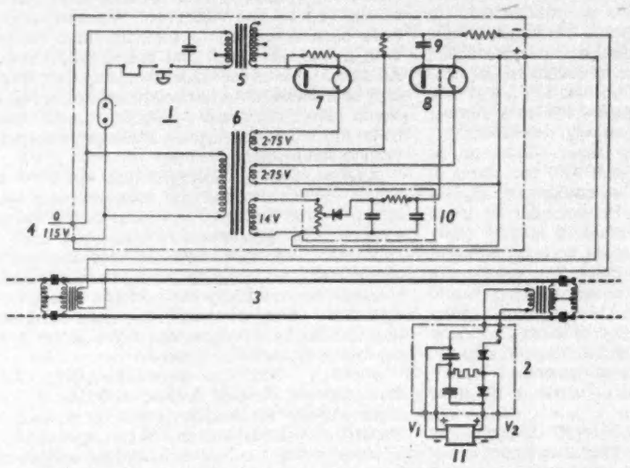
The satisfactory functioning of a track circuit depends on the quality of the contact established by the axles of a vehicle. When the rail surface is contaminated with rust, sand or grease, a voltage of 10V to 40V per contact, or 20V to 80V between rails (for one axle), may be required to break through this layer. If such a voltage were to be used it would mean an unacceptably high consumption of the order of several kilowatts. The principle of the impulse circuit therefore consists in applying the voltage periodically for very short intervals only. In practice, impulses of 5 milliseconds are used at intervals of 0·3 second; the intervals being used to accumulate the energy for sudden discharge. The theoretical mean power absorbed is then of the order of $^1/_{50}$W, although due to filament heating this figure is doubled in practice. A peak power of tens of kilowatts is attained. The circuit diagram is shown in Fig. 2. The mains condenser of 10μF is charged at 1500V, then discharged through the thyratron shown. At the receiver end, the energy of the impulses is picked up and integrated by a system of capacities and rectifiers and used to operate a 30,000Ω track relay.

For use on lines operating at 50 c/s a double relay has to be used which is also controlled by a relaxation circuit actuated by induced currents due to unbalance between the two rails of the return traction current.

For a resistance of 2Ω between the two rails, maximum sections of 1000m can be employed. Of this kind of device, approximately 250 have already been installed, and 500 more are due to go into operation by the end of the year.

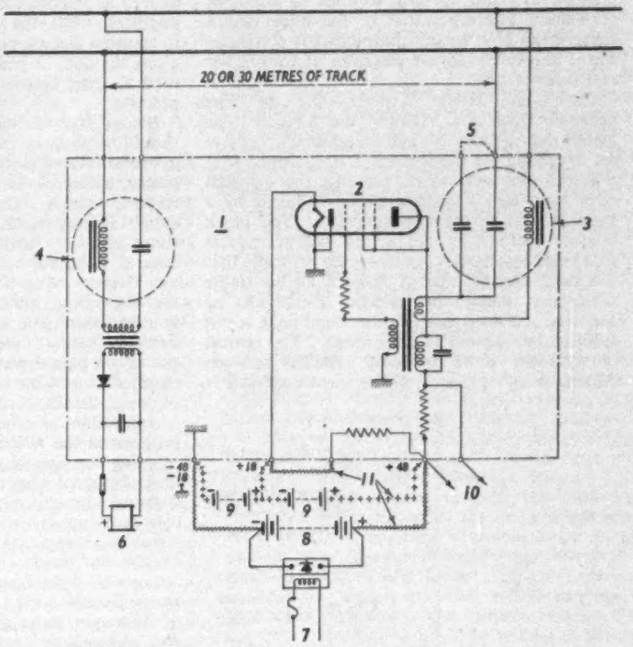
Jointless Electronic Track Circuit for 8700 c/s.—The growing use of continuous track in France raises many problems in connection with track-circuit controlled level crossings, because of the difficulty of inserting isolating joints. One completely satisfactory solution has been to install a circuit, without joints, of very small length (only 20m to 30m) which operates a high frequency (8700 c/s). This circuit functions when a train arrives within 20m of the beginning of the circuit until it has covered about 40m from the end of the circuit. This system can be superimposed without danger of mutual interference upon a long circuit operating on 850 c/s. The circuit is shown in Fig. 3. A triode-connected pentode acts as oscillator, with resonant coupling between grid and anode. The voltage from the output transformer is connected to the track by way of a series filter, the purpose of which is to suppress parasitic currents from the rails. The valveless receiver is connected to the track by way of a similar filter and comprises a step-up transformer, plate rectifier and smoothing capacity, the output current being supplied to a 400Ω relay. Because of the lower power consumption of 5VA, the equipment can be supplied either from automatically-charged accumulators or from a dry battery. Tension between the rails is about 0·5V. The voltage ratio between the ends is at least two, and the guaranteed shunt, 0·5Ω.

Track Circuit Equipped with Electric Joints.—The "electric joints" in question are combinations of self-inductances and capacities which permit an electric separation of the section without the need of insulating joints. The self-inductance is that of a length of track which, together with a suitable condenser, constitutes a circuit which, at the resonant frequency, has an impedance of several ohms. The basic scheme is illustrated in Figs. 4 (*a*) and (*b*); this diagram shows, however, that a single axle in the position of the short-circuit cable would remain undetected. In order to obviate this possibility, the circuit is carried out as in Fig. 4 (*c*), the properties of which are similar; there is, however, an overlapping effect of a shunt on the neighbouring circuit, which is of advantage. The whole track circuit comprises a "feeder joint," a length of track (maximum 800m), and a "receiver joint." The self-inductances of the rails are low and the resonant frequencies, and hence the frequencies of operation, are somewhat high—1600 to 2800 c/s. Because of the low power requirements (of the order of 2W), transistors can be used for both transmitters and receivers. Supply voltage is 8V, and the sets can be put into service instantaneously. The equipment can be used as relay, thereby making it



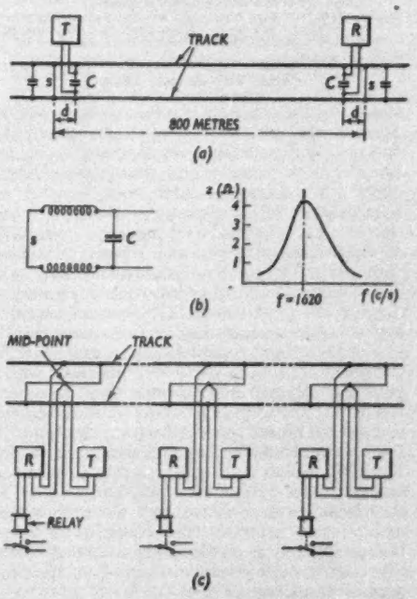
1—Transmitter.
2—Receiver.
3—Track.
4—Mains 115V, 50 or 83 c/s.
5 and 6—Transformers.
7—Rectifier.
8—Thyratron.
9—10μF condenser.
10—Triggering circuit.
11—Relay.

Fig. 2—Diagram for high-tension impulse circuit



1—Transmitter-receiver.
2—Oscillator.
3 and 4—Filters.
5—Dotted connection for track length of 20m. This connection is removed for track length of 30m.
6—Relay.
7—Mains supply, 115V, 50 c/s.
8—Twenty-four accumulator cells (20Ah).
9—Dry cells.
10—Connection for testing valve.
11—Alternative connections depending on whether accumulators or dry batteries are to be used.

Fig. 3—Track circuit for 8700 c/s

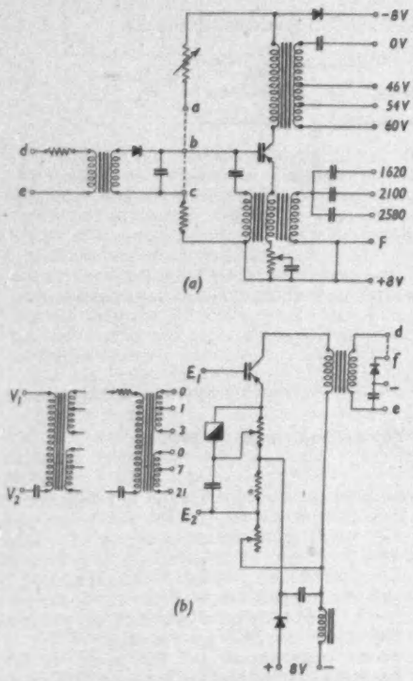


(*a*) Basic circuit. *T* transmitter, *R* receiver.
(*b*) Electrical equivalent to track length *d*, showing variation of impedance with frequency.
(*c*) Unsymmetrical arrangement of short circuit in order to prevent possibility of a single axle not being indicated.

Fig. 4—Track circuits with electric joints

possible to build up long sections in multiples of 800m. The separation of the track circuit signal from any traction harmonics is complete. Fig. 5 shows the circuit diagrams of transmitter and receiver.

Centralised Traffic Control.—On the line between Dole and Vallorbe the S.N.C.F. has installed a system of automatic block control for operating the single-track line, equipped with a directional lock which prevents the dispatch of a train into a section already entered by a train from the opposite direction. The block control operates in conjunction with transistorised electronic track circuits on the principle that a special electric current flows if all the traffic conditions along the selected route are as required ; if even one of these conditions is not fulfilled the current is interrupted. The central control box which is being installed between Muchard and Frasnes is also electronic and is



(*a*) Transmitter for track 1 delivers the frequencies 160, 2100 and 2580 c/s. Transmitter for track 2 delivers frequencies of 1860, 2340 and 2820 c/s. If used as transmitter, terminals *a*, *b* and *c* are joined, *d* and *e* are not used. For use as a relay terminals *a*, *b* and *c* are disconnected, *d* and *e* are joined to the same terminals as the receiver.
(*b*) For use as receiver, *d* and *f* are joined, (—) and *e* are connected to the relay. For use as a relay, *d* and *f* are disconnected, *d* and *e* are joined to the same transmitter terminals.

Fig. 5—Transmitter (*a*) and receiver (*b*) for track circuit with electric joints

stated to have a greatly superior performance to previous mechanical designs. In the latter, the passage of a command or control code takes three to four seconds, and considerable delays occur when numerous commands have to be transmitted. In these classical installations, the operator has to actuate as many levers or buttons as there are indicators and signals connected with the traffic route which is to be lined up. The electronic control centre deals with a command code in 0·4 second. The control impulses are not sent out only when an instrument indication changes, but are periodically repeated in their entirety by a sweep every two seconds, which gives the best possible assurance that the system is working properly. The lining up is carried out simply by pressing a single route button. A further simplification has been developed by the S.N.C.F., which consists in storing in advance several routes to be lined up automatically in succession, in accordance with the train movements as they proceed. The passage of the trains is indicated on a mimic panel to the operator whose only work consists in setting up the programme from time to time.

It is claimed that the advantages of the new system lie not only in the field of traffic control, but that the installation itself is cheaper than older ones, as the same cable can be used for several channels. Thus, two conductor pairs of a four-core cable serve to transmit telephony as well as remote control signals and command impulses, while the phantom circuits are used to transmit electric power to various installations along the line. Variants of this principle can be used to meet special cases which may occur in practice.

Before such a system is installed, a study should be made of the factors which apply, such as traffic volume, siting of the station and turn-out tracks, speed of the different trains ; kind of traction—steam, diesel or electric ; electricity supply for the signal installation ; danger from snow and ice ; and details of the programme control required. Such a study, it is stated, would then make possible an installation with the following advantages :—Optimum traffic volume for minimum capital cost (single track) ; complete safety ; maximum reduction in manpower ; a high degree of automation ; and easy maintenance of the equipment due to a number of design details which have been developed.

Automation of Shunting Yards.—Trials are in progress at the Achères yard with the object of studying the possibilities of automation applied to shunting of wagons. In particular, a device is being studied which would be able to apply optimum braking to wagons coming downhill from the hump. At present the wagons are braked by hand. Automatic braking would require an instantaneous knowledge of a great many factors, such as the coefficient of friction of the wagon, its weight, height, the wind velocity, &c. It would thus require an electronic " brain " to take into account the influence of all these factors.

Remote Control of a Shunting Engine.—By means of the short-wave transmitter shown in our first illustration one can continuously control from a fixed post the speed and direction of travel (including " stop ") of a " Model 0-4-0 DA " diesel shunting locomotive. The controls consist of a lever which can be moved over a quadrant graduated between 0 and 40km per hour. The speed set in this way is attained by the engine, within the limits of its power, whatever might be the load attached to it or the gradient of the track. Transmission is effected by a carrier wave of 160 Mc/s modulated by a frequency of 1000 c/s. The modulation frequency is periodically interrupted in such a way that the ratio of transmission time : total time corresponds to the speed required. The receiver on the engine automatically compensates for intensity variations of the reception and integrates the signals, the output taking the form of a voltage proportional to the speed which is opposed by the voltage from a tachometer dynamo connected to the wheels. The difference voltage actuates an electronic circuit comprising a two-stage magnetic amplifier which in turn operates an electro-pneumatic servo motor controlling the speed and braking. The normal controls have not been altered in any way so that one can very simply change over to manual operation.

The change of gear to forward, neutral or reverse is carried out by three low frequencies (135, 170 and 205 c/s respectively). " Memory relays " in conjunction with time delays allow the engine to be reversed from any speed.

Measurement and Research Apparatus

Mechanical Strength of Rolling Stock.—The principal forces acting upon a railway vehicle in use are static and dynamic vertical loads, the pull on the couplings, compressive forces and impacts on the buffers, and vibrations. Various means have been developed to measure these forces, both in the laboratory and during actual runs. As an example of full-scale laboratory tests there may be mentioned the test bed illustrated in Fig. 6 which allows compressive forces up to 900 tons to be applied to carriages. This equipment has been in service since 1951.

Soundproofing of Rolling Stock.—In 1950, a special section dealing with soundproofing was set up within the S.N.C.F. Most of the equipment in this department is electronic, and is concerned with measuring and recording noise and its analysis. Soundproofing standards have already been markedly improved as a result of this work. Similar studies have been made on engines, chiefly diesel engines, whose noise level has been substantially reduced.

Stability and Passenger Comfort.—The Research and Testing Section of S.N.C.F. has acquired very full instrumentation for its work in connection with the stability of carriages and the effect on riding comfort. Most of the equipment is electronic and depends upon the piezo-electric effect.

Miscellaneous Researches.—The fact that the S.N.C.F. possesses a very wide range of electronic research tools, makes it possible to study experimentally many other mechanical problems, such as the elastic attachment of the track, soil vibrations caused by trains, equipment for checking overhead conductor wires, and others. The Research Section also develops and tests rolling stock designed for special studies, such as a carriage for measuring the effects of acceleration and displacement of the superstructure, a carriage for checking the state of the track, and a pendulum vehicle which is capable of rounding curves at high speed without discomfort to the passengers. (A description of the pendulum carriage will be found in THE ENGINEER, April 12, 1957, page 584.)

Work has also been carried out on behalf of other organisations in connection with special problems, e.g. for the Ministère des Ponts et Chaussées regarding the raising of the Morand Bridge at Lyon, and for the S.N.E.C.M.A. concerning the landing of the " Flying Atar."

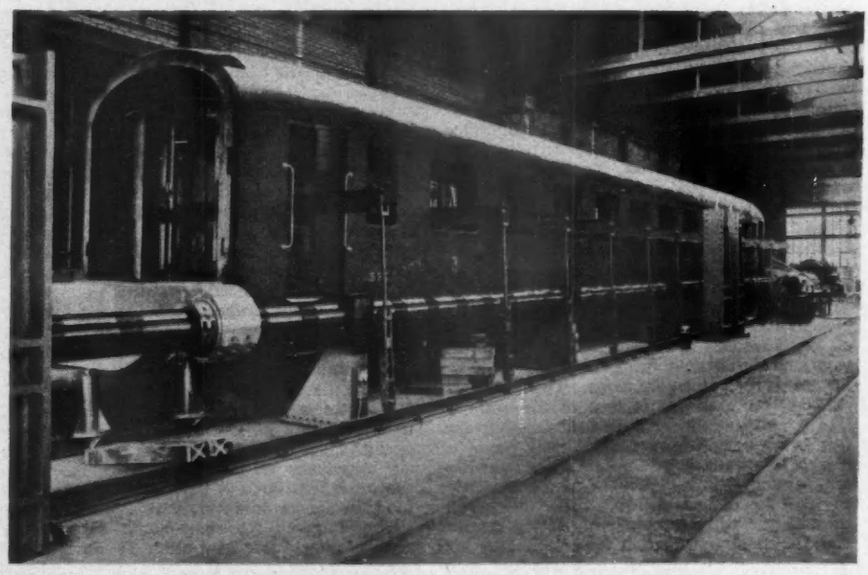


Fig. 6—900-ton test bed for full-scale tests on carriages

Ultrasonic Progress

By OUR AMERICAN EDITOR

AMONG the many suppliers to the California works of Convair, which turns out the "Atlas" guided missile, is a small firm on Long Island called Acoustica Associates. As its name perhaps would suggest, Acoustica is in the business of ultrasonics. Among other things, it produces a device called an "ultrasonic liquid-level sensor," which is in such demand that only recently the company had to open its own manufacturing plant in California. This ingenious device measures the amount of rocket fuel and liquid oxygen in the tanks of the "Atlas," apportions their flow and even shuts off an empty tank and opens a full one when necessary. Aboard a missile travelling through outer space, it is so perceptive that the inevitable sloshing and bubbling of the fuel fail to distract it. Liquid level sensing represents but one of a large variety of ways in which ultrasonics—the outgrowth of wartime "sonar"—is making itself heard to-day. There is already, for example, a dentist's drill based on the principle, and another for boring oil wells. In hospital rooms, ultrasonic equipment is available for sterilising instruments and for giving diathermy treatments; it has been used to remove brain tumours without surgery and to ease the pain of childbirth. Process industries, moreover, are finding "silent sound" a useful tool for measurement and control; for detection of flaws in metallic objects, and for soldering and welding metals which otherwise are non-adhesive. It can "tenderise" food, tune television sets by remote control, search out fish in the ocean and, paradoxically enough, set off burglar alarms. Most commonly, ultrasonics is being employed commercially to clean the intricate mechanisms of cash registers, wrist watches and electronic computers. The success of this application, in fact, has prompted some manufacturers to start developing washing machines and even coffee pots for consumers—the first attempts to get ultrasonics into the American home.

The industry causing all this stir is young and eager. It boasts its own trade organisation, the Ultrasonic Manufacturers Association, and its own trade magazine, *Ultrasonic News*. Next November the industry plans to assemble its wares in New York for the first "all-ultrasonics" exhibition in history. In addition to Acoustica, quite a few well-known companies are venturing into silent sound. American Telephone, R.C.A., General Electric, Westinghouse, Sylvania and Avco Manufacturing, for example, are among those participating in ultrasonics research and experiment. The industry's two leaders are Raytheon, which developed "sonar" and has its own line of ultrasonic equipment, and Bendix Aviation, which also manufactures several devices. Two other companies involved in ultrasonics are Curtiss-Wright, which turns out cleaning and testing machines, and the Clevite Corporation, which makes one of the vital ingredients, piezoelectric crystals. In wartime, "sonar" transduction was performed by piezoelectric crystals of a material such as quartz, which change shape when current is passed through them. Quartz was a satisfactory material for simply sending and receiving sound. An advancing technology, however, needed ultrasonic transducers of greater strength and heat-resistance. As time went on, new materials were found, among them barium titanate and certain ceramics, such as lead titanate zirconate. The Clevite Corporation, through its Brush Electronics Division, for years has led in these developments. Piezoelectric crystals and ceramics, however, were not a complete solution. The post-war electronics industry wanted to apply ultrasonics to uses requiring even greater durability. Thus, a second kind of transducer was developed—one that converted high-frequency electricity into sound which could be used as physical energy. This, the "magnetostrictive" transducer, makes use of a property possessed in high degree by certain metals, particularly nickel. When nickel finds itself in an alternating magnetic field, it tends alternately to stretch and to contract. By introducing alternating current into a coil, which is wrapped around a stack of small nickel plates, a magnetic field is set up and the nickel stack is set to vibrating. These vibrations cause the sound waves. When the current is of supersonic frequency, say, 25,000 c/s, the nickel, too, will vibrate at a like rate. Magnostrictive transducers have opened up for silent sound such heavy industrial applications as welding and impact-grinding.

Mechanical Applications

To-day, ultrasonics is being put to the test of the market place in three major forms. One is the use of vibrations directly as mechanical power, to alter the physical status or shape of materials, in a variety of machine tools. Another is the application of "cavitation" for cleaning and degreasing. The third is the simple ability of the ultrasonic waves to "listen," in instruments which can scan, measure and test. The most important mechanical application is the impact-grinder, which is manufactured by Raytheon, Bendix Aviation and the Cavitron Equipment Corporation. In such units, the transducer's vibrations are transferred directly to an attached cutting tool which may be of any "soft" metal, even copper or brass. The tool pounds insistently into a slurry of abrasive chemicals. Beneath the abrasives lies a material which, in seconds, or, at most, minutes, will contain an exact reproduction of the shape of the tool face, cut by the abrasives. Since intricacy of design is no restriction, the process makes it possible to perform such difficult jobs as die-shaping tool steels, carving precious gems and glass and even drilling teeth, better and faster than by more conventional means. The well-known dentist's drill, however, which Cavitron has had on the market for some time, of late seems to have ground almost to a halt. The company says the tool was selling well prior to the spring of 1957. Being "soundless" and painless, it permits more extensive work at a sitting without anæsthesia, and does an excellent job as well. However, it costs more. Consequently, when two of Cavitron's principal competitors for the dental business brought out high-speed rotary (non-sonic) drills which were sufficiently competitive, the latter firm suffered a not-so-painless "sharp decrease in the sale of its dental unit."

Impact Grinding and Welding

On the industrial scene, impact grinding is filling a wider gap. Certain precision tasks of this kind can be done only by ultrasonics. In others, cost savings of as much as 80 per cent over standard methods of drilling and grinding have been achieved. The ultrasonic impact grinding equipment sells for around 7000 dollars. So far, the industry has placed some 500 installations, of which Raytheon sold 300, Bendix 200. Now Raytheon has introduced a smaller, "bench" model, selling for 2700 dollars, and the company hopes to reach a wholly untapped market of less affluent manufacturers. Another important ultrasonic machine tool is the welder. The leading producer, by far, is Aeroprojects, Incorporated, which has had such a machine on the market since 1949. The special attraction of its "Sonoweld" set is the ability to weld any metal of nearly any thickness. No material has been encountered so far, according to the company, which cannot be joined. Metals common to electronics, missiles and aircraft and not easy to weld, thus are natural targets for the Aeroprojects machine. These include copper, nickel and aluminium, and a joint between sheets of 0·00015in to 0·04in thickness can be handled. "Sonoweld" makes use of the magnetostrictive transducer, focusing ultrasonic waves at the point of contact for one second. While the engineers do not know precisely what happens, they believe that the sound waves break up the molecular structure of the two surfaces and cause them to interlock. No melting or fusing takes place. Aeroprojects has applied its ultrasonics knowledge to the development of a sister device for soldering, called "Sonobond." Another company, Gulton Industries, has entered the field with what it describes as the "first automated, continuous-seam ultrasonic welder." It, too, can join such difficult metals as aluminium and, in fact, was developed to specific standards for a military aircraft project. A big machine, it has eight welding heads and can join a seam at the rate of 200in per minute.

Cleaning

The field of "cleaning," to date, has been the biggest of ultrasonics' commercial markets. Here it serves missile and aircraft makers, producers of computers and business machines, the jewelled watch industry and many others involved in "miniaturisation." Textile firms are experimenting with the process in dyeing. The greatest source of sales to date has been the American hospitals, which are using ultrasonics for sterilising equipment. High-frequency sound agitates water at a rate of thousands of times per second, whipping the liquid into an apparent frenzy. By itself, water thus treated can clean practically anything. The industry makes the job even quicker and easier by adding a variety of specially formulated detergents. Detrex Chemical, which invented the commercial cleaning device, produces the bulk of the chemicals used as well. Among the many competitors of Detrex, Bendix Aviation, the leader in this field, has a tank it calls the largest in the world for ultrasonic cleaning (5ft in diameter and 4ft deep). In it a jet engine can be scrubbed in "six man-hours," as against the former thirty-seven man-hours; the resulting savings to the U.S. Air Force will be 400,000 dollars a year. Curtiss-Wright has a degreasing machine which cleans 95 per cent of the pre-assembled parts in a turbo-jet engine in minutes.

Sensing and Testing Devices

Finally, ultrasonic waves are used as sensors, yardsticks and testers—in short, for "listening." This is the largest, historically the first, and essentially the simplest of all uses of ultrasonics. The reason, of course, is that it includes the military application, "sonar." The commercial developments of the "sonar" principle are among the most promising in ultrasonics. They range far and wide. Raytheon, for example, has on the market a miniature "sonar" device for pleasure boats. Called the "echo depth sounder," it plumbs the bottom of the sea to help amateur navigators through shallow waters, and charts its findings. A similar device is the "Fishscope," marketed by the Edo Corporation. It is used to detect whole schools of fish, revealing their whereabouts on a small "scope." Another special application of the same principle is in the amazing burglar and fire alarm made by Walter Kidde. Inside this device is a stack of nickel plates, made magnetostrictive by an electric current, generated at 19,000 c/s. As the nickel throbs, it sets to vibrating an inverted diaphragm, or "can," in which it is enclosed. The diaphragm swamps the room with continuous "silent-sound" waves. If these are disturbed by air currents even as slight as those caused by the burning of a match—much less the movement of a man—the alarm responds. Insurance underwriters think so much of this development that they are said to allow a discount of up to 60 per cent on premiums, wherever the Kidde ultrasonic device is connected to a central alarm-sounding system.

So far, the biggest commercial uses stemming directly from "sonar" are in measuring and testing. Here the principle is that ultrasonic waves are transmitted into a process or a material; the intensity of the waves as they rebound, and the time lag involved, indicate any interruptions encountered on the way. In ultrasonics testing, Curtiss-Wright plays a major part. Its instrument, the "Immerscope," submerges metal parts in a water bath, so that items of varying sizes can be tested quickly by an assembly line process. The acknowledged leader in this field in America,

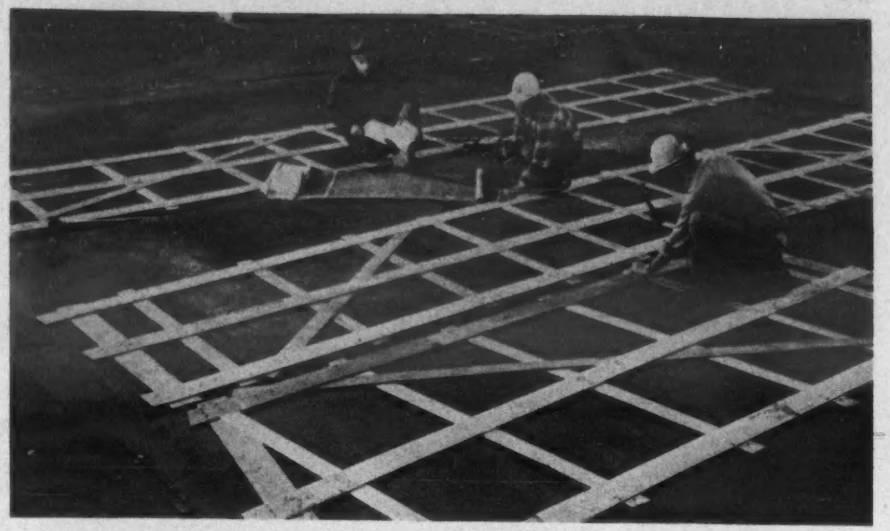


Fig. 1—Conventional mould loft practice, with loftsmen using full-scale wooden or paper templates

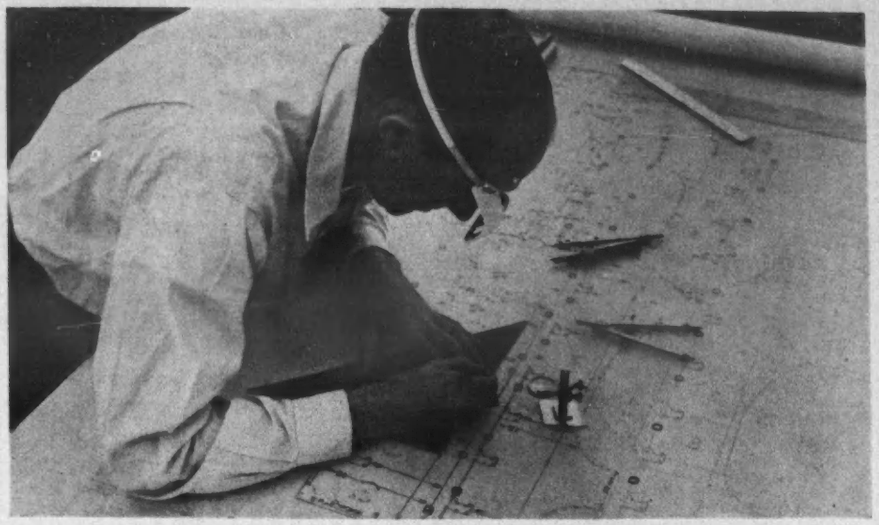


Fig. 2—Optical draughtsman preparing detail drawings of hull to one-tenth scale for subsequent photographing on 4in by 5in plates

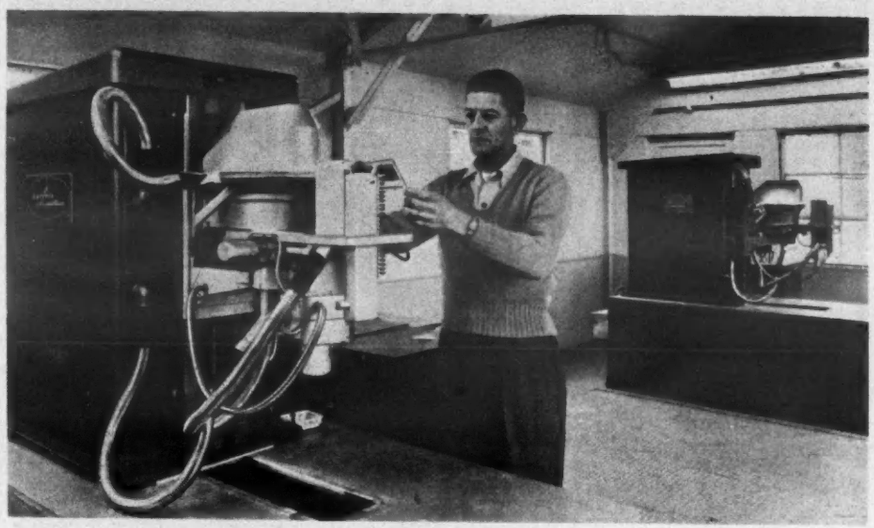


Fig. 3—One of the two optical projectors being set up to apply the detail dimensions to steel plates below

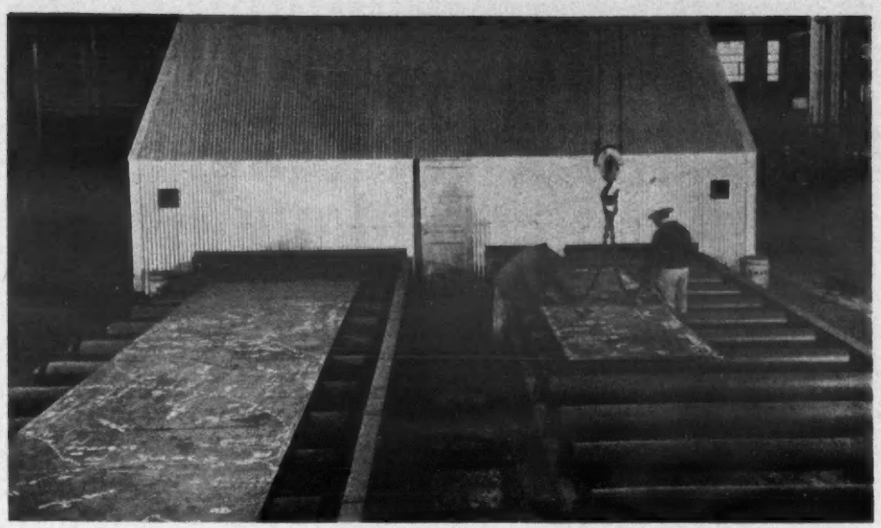


Fig. 4—Optically marked steel plates leaving the dark projecting booth through slots over roller tables

however, is Sperry Products. This company has a portable device called the "Reflectoscope." The size of a small television set, it has a cathode-ray oscilloscope screen on which imperfections are visible. The operator places the small "search unit" on the surface and reads the result. The handy device, probing as deep as 3ft into solid steel, eliminates the necessity of dismantling large machinery for testing purposes. Sperry also now has a number of novel testing equipments for the railway industry; they are ultrasonic "Detector Cars," of which there are seventeen, all owned by Sperry itself, valued at 200,000 dollars each. They are fully equipped testing laboratories on wheels, for lease to the railways; running along the tracks, they ultrasonically scan every inch of rail for flaws which can cause engine wear or even derailment.

Ultrasonics in Medicine

These, then, are a few of the incredibly varied "silent-sound" products now in use. Just over the horizon are many more. Some of the most exciting experiments to-day are being conducted in medicine. So far, diathermic treatments have been tried with notable success. Ultrasonic waves applied directly to the skin appear to ease pain and to cure at least partially such ailments as lumbago, ulcers and arthritis. As a safe method for relieving the pain of childbirth, ultrasonics has been applied successfully. Further applications in medicine and even in surgery are being tried. Instruments to measure the healing of a bone fracture, the circulation of blood and the beat of a heart now are being tested by doctors. Beyond that, the use of sound in operations may prove revolutionary. Yale physiologists, supported by Raytheon, have experimented with breaking up kidney stones by "focusing one or more tiny beams" of ultrasound on the affected areas. Automation Instruments, among others, is assisting in experiments such as a series at the University of Iowa, where brain tumours have been excised. Barring unforeseen injury to surrounding body cells, it appears possible that many types of cancer eventually may prove vulnerable to the ultrasonic ray. Possible developments in industry are equally promising. Homogenising milk and other products and tenderising meat appear possible with ultrasonics. At the Battelle Memorial Institute, a group is attempting to gin cotton with silent sound—the first new concept in this field since Eli Whitney's famous invention of over a century ago. Even the "cavitation" principle of cleaning offers new possibilities—notably in home appliances. The oft-discussed ultrasonic washing machine is a semi-secret project at Hotpoint, and Gulton Industries is attempting to have an ultrasonic coffee percolator ready commercially in the near future. Altogether, then, the technology of ultrasonics is developing a great number of important and practical uses which should contribute considerably to industrial progress in general.

Shipyard Optical Marking Installation

THE Newport News Shipbuilding and Dry Dock Company recently installed an interesting optical marking system at its Newport News yard in Virginia. The so-called "Lumotrace" system is an optical method of layout which uses reduced scale tracings to provide full scale information for marking off steel plates. The important aspect of it is that lines of light can be projected from a very small scale—one-tenth that of standard drawings—to actual size with sufficient accuracy to be practical in shipbuilding. The accuracy of plates marked off by "Lumotrace" compares favourably enough with those marked by long-standing mould loft practice, in which skilled loftsmen build and use full-scale templates of wood or paper, as shown in Fig. 1.

The full-scale template system of layout with its hand-made moulds survived because none other had ever been devised which could duplicate the extreme accuracy achieved by its highly skilled loftsmen. This work requires a tremendous area, which is the reason for the loft size of over 100,000 square feet at Newport News. Taking the design drawings from the hull design division, the layout section loftsmen fair in the body lines in full scale on the loft floor. The final offsets or points on this body plan are picked off and tabulated and returned to the drawing office for use in making the ship's working drawings. This operation is known as proofing the body lines. From the working drawings, the loftsmen build full-scale wooden or paper templates, commonly known as moulds. These are sent below to the layoff section, where they are used in marking off the steel plate in actual size for cutting and fabricating. When the moulds are no longer needed, they are stored for future use. Since hundreds are required for each ship, the areas and time involved in storing, moving and re-checking them for re-use is a problem in itself.

The "Lumotrace" system solves the same problem—that of transferring dimensions and forms from the design drawings to the steel plate—but its method differs greatly from that of the full-scale mould. The work is begun by optical detailers, who reduce the design drawings to one-tenth scale and fair-in the body lines on large aluminium tables, as shown in Fig. 2. The body plan is laid out, also in one-tenth scale, and final offsets are taken off for proofing the body plan. When the working drawings are received from the hull design drawing office, they are detailed in one-tenth scale pencil layouts, from which tracings on "Lumotrace" acetate tracing film are taken. In many cases, both sides of the tracing are used, one for port and the other for starboard. Photographing the tracing produces a 4in by 5in glass plate negative, which is developed for use in the projector shown in Fig. 3. The image is projected and the lines of light are thrown through the darkened hood on to the steel on the marking tables below as illustrated in Fig. 4. The layoff men mark the steel directly from the lines of light projected. Once the negatives for a ship are made, they are instantly available for re-use, and their storage or deterioration is never a problem. The advantages of their duplication, for safekeeping or for multiple ship construction in other locations, is obvious.

The installation of the "Lumotrace" equipment required certain construction changes to the mould loft building. These included partitioning-off a section of the loft floor for a new air-conditioned optical detailing drawing office. A projector room was added on top of the building to house the projectors. The firm also erected a light-proofed hood to enclose the projected lines of light from the projectors on the roof to the marking tables on the ground level, and the roll-on, marking and roll-off tables, indicated in Fig. 5. The handling and flow of plates to be marked presented the greatest problem, and was resolved only after months of survey, tests and study. The procedure adopted, by which the materials move through the hood-covered marking tables from west to east, involved many adjustments and changes, including modification and rerouting of portions of the yard's railway tracks.

It is of interest to note that with regard to the space required for the marking operation, the booth and tables for "Lumotrace" take up only 16,000 square feet, as compared to 35,000 square feet for marking and over 35,000 square feet more for moulds storage required by the old system. Gradually, as new construction is begun and the "Lumotrace" system builds its stock of negatives, it is expected to assume an increasing percentage of the work load. Limitations, however, make it impractical for certain jobs, such as the layout of shapes and brackets. These will continue to be done by moulds in the layout shop.

The idea of using optics as a tool to increase layout productivity was conceived in 1942 by Johannes Kriepke, then works manager of a shipyard at Schinhau in Germany. Completing his first prototype projector in 1942, he came to the obvious conclusion that optics held the key to the elimination of templates by marking the steel directly. During the next few years, he and Karl Meyer, a German precision optics expert, devised the techniques necessary for practical reduced scale layout, and developed the optical system of sufficient accuracy to do the job. By

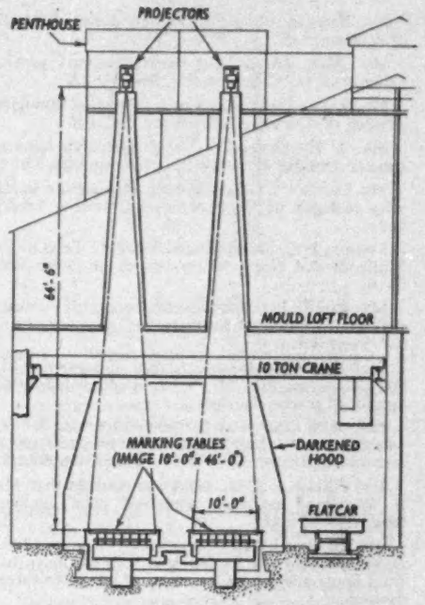


Fig. 5—General arrangement of "Lumotrace" projectors and marking tables

1948, Kriepke and Meyer had made trial installations in two European yards and formed their own firm, the Gesellschaft für Anzeichen Geräte, to produce the optical components. The installation at Newport News is the third at an American yard and is considered to be the most modern and most effective layout system so far put in at any shipyard.

Construction of Navajo Dam in New Mexico

THE U.S. Bureau of Reclamation has invited bids for the construction of the Navajo dam in north-central New Mexico, a major feature of the Colorado River Storage Project. The Navajo dam will be a 405ft high, 3600ft long earthfill structure and will be the third storage unit initiated on the Colorado Storage Project. Preliminary work on the Glen Canyon dam in north-central Arizona and the Flaming Gorge dam in north-eastern Utah was initiated in October, 1956. The prime contract for the Glen Canyon dam was awarded a year ago and a contract for the Flaming Gorge dam is expected to be awarded shortly.

The Navajo dam will be in Rio Arriba County, 34 miles north-east of Farmington on the San Juan river. It will create a reservoir at about 6000ft elevation with a total capacity of 1,700,000 acre-feet which will serve as storage and river regulation, aid sedimentation control, and provide irrigation water. The estimated total cost of the Navajo dam and reservoir storage unit is 42,000,000 dollars. In addition to river regulation and replacement storage, the unit will provide water for the Navajo Indian Irrigation Project, planned by the U.S. Bureau of Indian Affairs. The project canal system would provide irrigation water for about 115,000 acres for Navajo Indians. The San Juan–Chama project would divert 110,000 acre-feet of water annually from the headwaters of the San Juan river in south-central Colorado into the Rio Chama in New Mexico for use in the Rio Grande Basin in north-central New Mexico. The imported waters would be used for an additional municipal and industrial water supply for the city of Albuquerque, a supplemental irrigation supply to 39,300 acres in the Cerro, Taos, Llano and Pojoaque tributary irrigation units in the Rio Grande Basin, and to provide supplemental water for irrigation to 81,600 square miles in the existing Middle Rio Grande Conservancy District.

Personal and Business

Appointments

MR. STANLEY FIELD has been appointed chairman of Venesta, Ltd.

MR. JOHN GOODE has been appointed general manager of G. A. Engineering Services, Ltd.

MR. RALPH GABRIEL has been appointed managing director of Charles Churchill and Co., Ltd.

MR. J. HENDERSON has been appointed foundry general manager of Hepworth and Grandage, Ltd.

MR. DAVID J. I. GRAY has been appointed technical sales manager of W. E. Norton (Machine Tools), Ltd.

STENOR, Ltd., has appointed Mr. J. C. Letts to the Midlands and North Wales area of its factor sales force.

MR. ROY F. BELCHER has been appointed publicity manager to Desoutter Brothers, Ltd., in succession to Mr. Peter Allen.

THE CINETRA MANUFACTURING COMPANY, Ltd., has announced that Mr. W. J. Raymont has been appointed general manager.

MR. R. J. TRISTRAM has been appointed by the Moss Gear Company, Ltd., as its technical representative to further the sales of automotive products.

THE NATIONAL COAL BOARD announces that Mr. S. Weinberg has been appointed chief engineer (specialist services).

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces that Mr. O. W. Minshull, M.I.E.E., has been appointed general manager of its power cables division.

MR. BERNARD F. KANE, M.I.E.E., has been appointed sales and technical representative in eastern Europe of Marconi's Wireless Telegraph Company, Ltd.

THE MINISTRY OF SUPPLY has announced that Mr. C. N. Jaques has been appointed deputy head of the Ministry of Supply staff and director, Guided Weapons and Electronics, at the British Joint Services Mission in Washington.

THE ELECTRICITY COUNCIL has appointed Mr. L. A. Corney, A.M.I.E.E., deputy chief safety officer. Mr. D. Hudson, Assoc.I.E.E., has been appointed to succeed Mr. Corney as regional safety officer in the north west, Merseyside and North Wales area.

THE BRITISH TRANSPORT COMMISSION has announced the appointment of Mr. R. C. Bond, chief mechanical engineer, British Railways central staff, to succeed Mr. John Ratter as technical adviser at Commission headquarters on October 1, 1958, when Mr. Ratter will become a full-time member of the Commission.

THE B.S.A. COMPANY, Ltd., states that following the reconstitution of Metal and Plastic Compacts, Ltd., as the Motoplas Company, Ltd., the following board of directors is announced: Mr. Edward Turner, Mr. D. J. Hardwicke, Mr. R. J. Fearon and Mr. J. W. Binsted. The secretary to the company is Mr. F. Ellinghouse.

DR. M. F. JORDAN has joined Murex Welding Processes, Ltd., as leader of the fundamental research section of the research department, in succession to Dr. W. D. Biggs who has taken up an appointment in the engineering department of Cambridge University. Mr. H. J. Wellard has also joined the fundamental research team.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION announces that Mr. A. G. Curtis has been appointed transport commissioner for Wales and Monmouthshire with effect from October 1, and Mr. I. Owen, chairman of Traffic Commissioners and Licensing Authority for the South Wales traffic area as well as deputy transport commissioner. Mr. C. R. Hodgson, the present chairman of the Traffic Commissioners and Licensing Authority for the South Wales traffic area, will take over from Mr. Curtis the chairmanship of the Traffic Commissioners and the Licensing Authority for the East Midland traffic area.

Business Announcements

CAWKELL RESEARCH AND ELECTRONICS, Ltd., has moved to Scotts Road, Southall, Middlesex (telephone, Southall 3702 and 5881).

THE INCANDESCENT HEAT COMPANY, Ltd., Smethwick, has announced the formation of a Gas Atmospheres Division headed by Mr. I. L. S. Golding.

ACHESON COLLOIDS, Ltd., announces that its publicity and advertising section is now located at 70, Hill Street, Richmond, Surrey (telephone, Richmond 5481/3).

BROOK MOTORS, Ltd., states that with effect from August 27, its London sales office will be transferred from Westminster to 1-2, Finsbury Square, E.C.2 (telephone, Metropolitan 9401/7).

AIR CONTROL INSTALLATIONS, Ltd., Ruislip, Middlesex, states that the whole of its ordinary share capital has been acquired by Beyer Peacock and Co., Ltd., Gorton, Manchester.

HANDY ANGLE, Ltd., states that arrangements have been concluded with H. Arendsen and Son (Pty.), Ltd., Melbourne, Australia, for the manufacture, under licence, of its range of slotted steel angle.

MR. E. G. KIMSEY, A.M.I.C.E., A.M.I.Mech.E., engineering contracts manager for Chamberlain Industries, Ltd., will be visiting the United States and Canada during the months of September and October to discuss the application of the "Staffa" slow speed, high torque, hydraulic motor.

FIRTH CLEVELAND INSTRUMENTS, Ltd., Treforest, Glamorganshire, announces that Mr. S. F. Smith, sales manager of the industrial instruments division, is visiting agents in Amsterdam this month. He will be accompanied by Mr. D. T. Broadbent, an executive director and chief engineer.

PARSONS MARINE TURBINE COMPANY, Ltd., announces that it has concluded an agreement for technical collaboration on the design and manufacture of marine steam turbines with Brown, Boveri and Co., Ltd., Baden, Switzerland. Compagnie Electro-Mecanique, Paris, will also be associated with this collaboration and development.

MASSEY-FERGUSON (GREAT BRITAIN), Ltd., is extending its factory at Barton Dock Road, Stretford, Manchester. The main factory building, which covers 300,000 square feet, is to be enlarged by another 100,000 square feet. The new extension will be used as a warehouse for finished machines and implements; there are now sixteen assembly lines at Barton Dock Road. Neodox, Ltd., is undertaking the project, and the site is at present being excavated. Massey-Ferguson is also enlarging the spares warehouse building at Ashburton Road, Trafford Park.

STONE AND WEBSTER ENGINEERING CORPORATION, 49, Federal Street, Boston, Mass., has announced the formation of a Dutch subsidiary, Stone and Webster Engineering N.V., with headquarters in The Hague. It has also announced that E. B. Badger and Sons, Ltd., which was merged with Stone and Webster in 1951, becomes Stone and Webster Engineering, Ltd., and the French subsidiary Etablissements Badger, S.A., will in future be known as Stone and Webster Engineering S.A. In Australia, the subsidiary company E. B. Badger and Sons Pty., Ltd., will in future be known as Stone and Webster Pty., Ltd.

Contracts

HALL RUSSELL AND CO., Ltd., announces that it has received an order from John Kelly, Ltd., of Belfast, for two cargo ships of 1350 tons deadweight, each powered by a British Polar M.46.M. diesel engine. The ships will be built in the yard of Alexander Hall and Co., Ltd.

J. M. J. MAUS, Ltd., states that its principal, Fried. Krupp Industriebau D., has received an order from Jernverks Oxelosund A.B., Sweden, for the design, supply and erection of two Kaldo converters, each of 100 tons capacity. These converters are to be installed as part of the ingot steel capacity of the new Swedish Steel Works. The International Construction Company, Ltd., London, is the consultant to the Swedish Steel Works.

THE GENERAL ELECTRIC COMPANY, Ltd., has received from the Anglo-American Corporation of South Africa a contract for electrical plant and equipment valued at £59,000. The order covers the driving motors, control gear and high-voltage switchgear for an a.c. winder to be installed at the President Brand Gold Mine in the Orange Free State. The new winder is designed to raise a maximum of 230 tons of rock per hour from a depth of 5600ft and is of the multi-drum Blair design, with four ropes and two skips. It is driven by two 6600V slipring motors with a combined output of 3600 h.p. at 600 r.p.m. The mechanical parts of the winder will be built in South Africa.

WILLIAM OLD, Ltd., has been awarded a contract for the main constructional work on the Ministry of Transport and Civil Aviation's £358,000 scheme for a two-level junction which will allow traffic on the Kingston by-pass to flow under the Surbiton–Leatherhead Road, A243, known as Hook Road. A large roundabout, incorporating two road bridges, will replace the existing roundabout at ground level and will be connected by four slip-roads to the trunk road, which will run in a cutting formed under the roundabout. The present scheme will improve the Kingston by-pass for a length of about three-quarters of a mile, the two existing 24ft wide carriageways being extended from the eastern end of the fly-under to Woodstock Lane. The works have been designed by Mr. D. S. Samuel, M.I.C.E., county engineer of the Surrey County Council.

THE CENTRAL ELECTRICITY GENERATING BOARD has placed contracts during the past month for power stations, transmission lines and transforming stations amounting in the aggregate to £6,464,543. The principal contracts include: Melksham substation, 275kV switchgear, Metropolitan-Vickers Electrical Company, Ltd.; Melksham-Bramley, 275kV overhead lines, J. L. Eve Construction Company, Ltd.; Rugby-Coventry, 132kV overhead lines, Balfour Beatty and Co., Ltd.; Canterbury substation, 132kV and 275kV switchgear, English Electric Company, Ltd.; Northfleet West substation, 132kV and 275kV switchgear, English Electric Company, Ltd.; Iver substation, two 120MVA, 275/66kV transformers, Crompton Parkinson, Ltd., and two 120MVA 275/132kV transformers, English Electric Company, Ltd.; Exeter substation, 132kV switchgear, General Electric Company, Ltd.; Checkerhouse substation, 132kV switchgear, A. Reyrolle and Co., Ltd.; High Marnham-Staythorpe, 275kV overhead line, British Insulated Callender's Construction Company, Ltd.; Agecroft substation, 132kV switchgear, Metropolitan-Vickers Electrical Company, Ltd.; West Melton substation, two 180MVA, 275/132kV transformers, British Thomson-Houston Company, Ltd.

Miscellanea

LLOYD'S REGISTER.—Lloyd's Register of Shipping has issued Notice Number 2120 which gives details of the additions and amendments made to certain chapters in the Society's Rules and Regulations for the Construction and Classification of Steel Ships, at meetings of the General Committee held on May 15 and July 3.

PROTECTIVE COATINGS.—A new protective paint, known as "Detel E/P" has been placed upon the market by Detel Products, Ltd., Victoria Park Estate, South Ruislip, Middlesex, to provide an industrial coating of exceptional thickness, combined with good resistance to chemicals, oils and generally corrosive conditions. The paint is formulated on an epoxy/pitch combination, so that to a thick water resistant pitch coating there is added the increased chemical resistance and hardness of epichlorhydrin resins. The material, being thixotropic, is easy to apply and it is stated that a 0·010in thickness can be built up in two coats.

CIVIL ENGINEERING SCHOLARSHIPS.—The Civil Engineering Scholarship Trust has announced the first eleven awards of scholarships which it administers. Worth on average nearly £400 per year each, these scholarships will enable the boys receiving them to begin a three or possibly four-year course for a civil engineering degree at university this autumn. The Trust received 117 applications and the eleven successful candidates were, we are advised, selected for academic ability and qualities of character, leadership and determination which are essential to make a good civil engineer. It is stated that the Trust will continue to award scholarships annually and that it expects to increase the number available next year.

NUCLEAR HANDLING COMPANY.—We have been informed that negotiations are nearly completed for the establishment of a jointly-owned British-American company to design and market remotely-controlled handling equipment for radioactive materials. The firm will supply mechanical and powered manipulators, reactor fuel loading and unloading systems, reactor maintenance systems, &c. The British partner is Savage and Parsons, Ltd. (Watford, Herts), a company that has been concerned with the design and manufacture of this type of equipment since 1954. The second partner is the Mechanical Division of General Mills, Inc. (Central Avenue, Minneapolis 13, Minnesota), which has designed and manufactured heavy-duty powered manipulators and reactor fuel charging systems since 1948. No announcement has been made regarding the name of the company, or where it will be registered, although it is expected to be in Great Britain. It is understood that the company will market the nuclear products of both partners throughout the world.

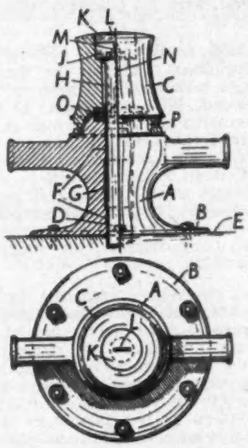
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

LIFTING DEVICES

798,117. April 15, 1957.—WINCH AND BOLLARD COMBINATIONS, Lionel Ashley Parsons, 536, Cameron Road South, Gate Pa, Tauranga, in the Dominion of New Zealand.

The invention relates to bollards and winches and particularly to marine bollards and winches. Its object is to form a winch and bollard in combination and in doing so to achieve greater simplicity and efficiency in construction and operation. As shown in the drawing, the winch operation is by means of a driving shaft *D* which passes up through the deck or other foundation *E*, to which the bollard base *B* is secured, loosely through a vertical central passage in the bollard section *F*, and is keyed by key *H* into the top rotating section *C*, which operates as the winch drum.



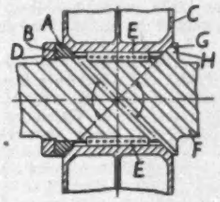
No. 798,117

The passage *F* may be of wider diameter at its centre section *G*, so that it forms a bearing top and bottom for the shaft with added clearance relief near its centre. The winch drum top is recessed at *J* and covered by a cap *K*. This allows, on removal of the cap, for the fastening and removal of the drum *C* from the shaft *D*, and also for a housing for a grease nipple *M* to grease, through channel *N*, the thrust bearing *O* which is machined half into the bottom of the drum *C* and half into the standing or bollard portion *A*. To facilitate the operation of the appliance as a winch, the driving power, which would normally be an electric motor, may be controlled by a conveniently situated foot-operated switch. In operation to haul in on a line or anchor warp fastened to the bollard *A*, the line or warp would be released from that bollard and two or three turns of line taken on the winch drum *C*, the loose part of the line pulled in and, by operating the foot switch, the winch drum rotated and the line hauled in as the winch drum revolves. When enough line has been hauled in the line is secured by taking several turns under and over the bollard part *A* in the usual manner. When hauling up mooring chains the buoy chain is hauled up on the winch gypsy *P* until the chain can be slipped into a permanent mooring hook fastened round the base of the bollard casting.—*July* 16, 1958.

POWER TRANSMISSION

798,142. February 27, 1956.—ATTACHMENT OF WHEELS, DISCS OR THE LIKE TO SHAFTS, The Parsons and Marine Engineering Turbine Research and Development Association, Pametrada Research Station, Wallsend, Northumberland. (*Inventor: Peter Michel.*)

The object of the invention is to provide attachment means which will maintain radial and axial location between a wheel, disc or the like and a shaft possessing different linear coefficients of expansion and different thermal conductivities irrespective of the rate of heating up or the magnitude of expansion of the two components when subject to an increase in temperature. Conveniently for assembly purposes, as illustrated in the drawing, one of the shaft frusto-conical faces *A* is formed on a close-fitting loose ring *B* held up to a wheel *C* by a nut *D*, the torque being transmitted by keys *E* and the other frusto-conical face *G* being formed on a shaft flange *H*. The wheel may be composed of an aluminium alloy having a linear coefficient of expansion about twice that of a carbon ferritic steel shaft and having a thermal conductivity of about four and a half times that of the shaft. The basic principle of this attachment is that when a conical body expands due to a rise in temperature the apex angle of the cone remains constant, and thus the axial differential



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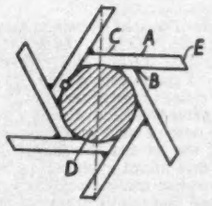
expansion between the members is compensated by the radial differential expansion, and the faces will always lie on the surfaces of the generating cones, thus retaining radial and axial location. In the case where the wheel is of aluminium alloy mounted on a steel shaft, where wear may take place on the locating faces, a belleville spring washer or other spring means can be fitted between the holding nut and the loose ring to accommodate this. The apex angle of the generating cone can be varied to enable the attachment to be used for mounting a wheel, disc or other object on a shaft.—*July* 16, 1958.

ELECTRICAL ENGINEERING

784,779. June 1, 1956.—DYNAMO-ELECTRIC MACHINE ROTOR SPIDER, The Allmanna Svenska Elektriska Aktiebolaget, Västeras, Sweden.

The invention relates to a dynamo-electric machine rotor spider of the kind comprising a hub and arms extending from the hub for carrying an annular armature core made from magnetic stampings. An advantage of the invention is that no separate hub is necessary as in the case of spiders used at present. Therefore it is a simple and inexpensive matter to construct a spider to fit inside a standard annular armature core and on to a non-standard generator shaft. Hitherto the cost of the separate hub has been a considerable part of the total cost of the spider. Referring to the drawing, *A* designates plane

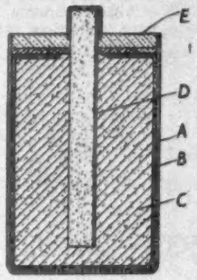


784,779

thick rectangular sheets and *B* the welded joints joining the sheets together. The parts *C* of the sheets between the welded joints form the sides of a tube or hub of polygonal section which is turned internally to fit a shaft *D*, and is provided with a key-groove. The hub is secured against rotation relative to the shaft by a key. The outer parts *E* of the sheets *A* form arms carrying an annular armature core.—*October* 16, 1957.

798,449. October 29, 1956.—A PRIMARY ELECTRIC CELL, P. R. Mallory and Co. Inc., 3029, East Washington Street, Indianapolis 6, State of Indiana, U.S.A.

The invention relates to primary dry cells and specifically to a galvanic cell utilising a mercurial compound as its depolariser. The objects are to provide a primary cell having a high ratio of current output capacity to cell volume, a relatively high ratio of current output above accepted cut-off voltage to total current output capacity, a substantially sustained voltage or flat voltage discharge curve with continuous output throughout relatively long cell life and a relatively long open circuit life without undue internal deterioration. As shown in the drawing the zinc can *A*, serving as container and anode, has a paper liner *B* which is coated with a 7 per cent solution of gelatine softened with the addition of a small amount of glycerine. After the liner has been placed in the container, the depolariser bobbin *C* together with waxed or silicone impregnated carbon rod *D* are inserted, the bobbin being compressed and expanded against the paper liner to afford good contact. The bobbin depolariser mix is made by milling seven parts of basic mercuric sulphate with one part of Shawinagin carbon black and adding one cubic centimetre of the electrolyte for each 2·5 grammes of depolariser. A wax impregnated cardboard disc is forced into the container to hold the top of the paper liner which folds over the bobbin under compression, hard wax *E* being poured on the

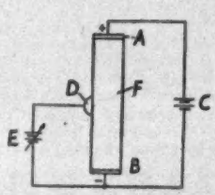


No. 798,449

spacer to seal the cell. A brass metal cap, having a small hole to permit escape of any gas, serves as a terminal contact for the cell. The open circuit electromotive force of the cell is sufficiently close to that of conventional zinc-carbon cells as to render it useful as a replacement unit, the cells of the invention having several times the ampere hour capacity of such conventional cells.—*July* 23, 1958.

794,425. October 1, 1954.—ELECTRICAL PULSE GENERATORS EMPLOYING SEMI-CONDUCTOR DEVICES, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor: Edgar Frederick Dawson.*)

The invention relates to electrical pulse generators employing semi-conductor devices and is applicable to the generation of either voltage or current pulses. The invention comprises a pulse generating arrangement including a "double base transistor" having first and second auxiliary electrodes adjacent each other at an intermediate position between the base electrodes and forming similar p-n junctions, means for applying a potential difference between the base electrodes to create a potential gradient along the semi-conductor rod, a condenser connected between one of the auxiliary electrodes and a base electrode and a load circuit connected between the same base electrode and the other auxiliary electrode, the arrangement being such that in operation the condenser is progressively charged until the potential reached renders the associated p-n junction conducting, whereupon the condenser discharges through the second auxiliary electrode and load circuit to generate a pulse. Referring to the drawing the transistor comprises a semi-conductor rod having base electrodes *A* and *B* at each end respectively, whilst a voltage source *C* is applied between the base electrodes. Substantially midway between the base electrodes is an auxiliary electrode *D* forming a p-n junction and an auxiliary variable voltage *E* is applied in an external circuit formed between *D* and the electrode *B*. If, in the arrangement shown, the electrode *A* is positive and *B* is negative there will be a potential gradient between them existing along the semi-conductor *F*. If *D* is positive with respect to the semi-conductor material (i.e. it may be a spot of indium applied to the surface of a germanium semi-conductor) then,



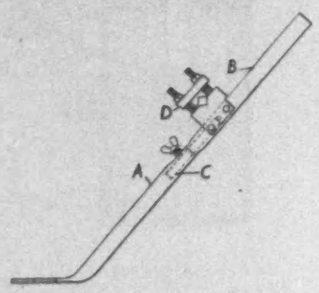
No. 794,425

due to the potential gradient between *A* and *B*, there will be a voltage existing in the semi-conductor material *F* at the junction point with *D*. If the potential applied to the junction *D* by the voltage *E* is lower than the value of the voltage between *A* and *B* at this position, it follows that the junction will be substantially non-conductive. If, however, *E* is progressively increased until the potential at *D* is of the same order as the value of the potential in the semi-conductor a value will be reached at which the path through the transistor *F* between *D* and *B* becomes highly conductive. The value at *E* at which this occurs is critical and this property is utilised for re-setting the sweep voltage condenser.—The specification also shows a circuit arrangement of such a double base transistor suitable for pulse generation.—*May* 7, 1958.

WORKSHOP TOOLS AND APPLIANCES

798,611. August 3, 1955.—A VICE AND A MOUNTING, The North Thames Gas Board, 30, Kensington Church Street, London, W.8. (*Inventor: Basil Arthurs.*)

The object of the invention is to provide a vice with a support which is easily portable. As the drawing shows, the support comprises two sections of



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tubing *A* and *B*. The section *B* is constricted at one end and has a short length of rod *C* projecting from it. The rod *C* fits in a corresponding socket in the end of the section *A* where it is held in position by a winged set screw. The section *A* has a foot rest projecting from the bottom end at an angle. The foot rest consists of a flattened section of the tube *A* with a cross piece fixed to it. A vice *D* welded to a base is fixed to the upper section of tubing *B* by bolts. When the vice and support are to be carried from place to place, the two sections of tubing are pulled apart. When the vice is assembled for use, the foot rest is placed flat on the ground and is held by a foot whilst the upper section of tubing is held in one hand in a position above the vice. When a long piece of pipe is held in the vice, it is not convenient to hold the support in the manner described above. In such cases, the tube is laid horizontally on the floor and the workman holds it in position standing astride the vice with both his feet on the tube.—*July* 23, 1958.

Technical Reports

The Distribution of Cathode Vapour in the Vicinity of an Arc Cathode Spot (Ref. L/T340). By A. E. Robson. The British Electrical and Allied Industries Research Association, Cleeve Road, Leatherhead, Surrey. Price 7s. 6d.—It is well known that evaporation of cathode material takes place from the current-carrying area of a cold arc cathode. This is demonstrated by the loss of mass of the cathode and by the appearance of the lines of the cathode material in the spectrum of the arc. The case with which this report is mainly concerned is the arc with a liquid mercury cathode running in mercury vapour at a vapour pressure of the order 10^{-3}mm Hg, but the general considerations apply equally well to arcs between metal electrodes such as copper in air, &c.

It is shown, by treating the evaporation from the small active cathode area as a problem in diffusion, that very large densities of vapour can be maintained at the cathode surface at the expense of only a comparatively small total flow of atoms, and hence a comparatively small energy loss. Furthermore, it is seen that these large densities fall off very rapidly at distances of the order of the spot radius until at distances of about ten times the spot radius the density is essentially the ambient vapour density in the arc vessel. Observation of the luminosity of an arc spot tends to confirm this. Finally, the treatment shows that by maintaining the high density of vapour immediately above the cathode, the latter experiences bombardment by atoms which back-diffuse from the region above it.

Heat Pump Sources: Heat Transfer from Soil to Buried Pipes (Ref. Y/T18). By M. V. Griffith, B.Sc., F.Inst.P. The British Electrical and Allied Industries Research Association, Cleeve Road, Leatherhead, Surrey. Price 12s. 6d.—The report describes tests carried out to determine the rate of heat absorption by buried pipes from the upper layers of the earth (London clay) when the heat is absorbed in chilled calcium chloride brine circulating in copper pipes of diameters up to 1in.

The main conclusions reached in the report are that, at depths up to 6ft from the surface, the steady rate of heat absorption varies from 30 to 60 B.Th.U. per hour per linear foot of pipe diameters ¼in to 1in for a wide variety of weather conditions. Lower values of heat absorption are obtained with ¼in pipes; little advantage is gained by increasing the diameter of the pipe from ½in to 1in. Tests described in the report show that, if a secondary circulating system of chilled calcium chloride brine at about 25 deg. Fah. is used, heat absorption at a rate of about 10kW can be obtained from a system of about 600ft of copper piping of ½in bore, laid horizontally in length of about 20ft, 1ft apart, at a depth of between 3ft and 6ft in London clay, with an average moisture content of 25 to 30 per cent. Therefore, a heat pump with a performance ratio of 3 : 1 would provide heat at a rate of about 15kW, when combined with a heat absorption system of the size and kind described.

The Effect of Filler Deficiency on the Performance of Cartridge Fuses, with Notes on a Suggested Filler-Deficiency Test (Ref. G/T308). By H. W. Baxter, B.Sc., M.I.E.E., and A. R. Galanides, B.Sc. The British Electrical and Allied Industries Research Association, Cleeve Road, Leatherhead, Surrey. Price 10s. 6d.—There has been recent discussion concerning the desirability of devising a test which will detect filler deficiency in a cartridge fuse. Before pursuing the matter it was thought desirable to establish whether a slight filler deficiency, such as might occur, for example, by superficially filling a cartridge but not compacting the filler, is likely to impair the breaking capacity of a fuse. The problem does not seem to have been investigated, although available evidence indicates that the omission of the part of the filler can adversely affect the breaking capacity and might lead to failure of a fuse operating near the limit of its capacity.

This report is divided into two parts. The first deals with a preliminary small-scale investigation of the effect of filler deficiency on breaking performance, and an appendix deals with an investigation of a suggested filler-deficiency test.

The Inflammability of Silicone, Melamine and Phenolic Resin Bonded Sheets (Ref. A/T139). By W. J. Renwick. The British Electrical and Allied Industries Research Association, Cleeve Road, Leatherhead, Surrey. Price 7s. 6d.—Insulating laminated sheets are now available which will operate at temperatures of the order of 200 deg. Cent., and, while much is known of their behaviour at such temperatures, less is known of their reactions to conditions likely to cause fire. To fill this gap a series of heat-resisting sheets bonded with phenolic, silicone and melamine resins was subjected to the fuse-wire, carbon arc and Barthel burner tests described in Appendices F, G and H of B.S. 737 : "Non-Ignitable and Self-Extinguishing Boards (with Mineral Base) for Electrical Purposes." Two sheets complying with this specification were included to provide a basis for comparison.

Flow in a Jet Directed Normal to the Wind. By R. Jordinson, B.Sc., D.I.C., M.Sc. Reports and Memoranda No. 3074. H.M. Stationery Office. Price 6s. 6d.—Experiments to study the flow in an air jet, which is ejected normal to an air stream from an orifice in a plane floor, have been made for several values of the ratio of wind velocity to jet exit velocity. The path of the jet and the shape of the jet cross section were determined; this cross section was found to be of horseshoe shape away from the orifice. It was also found that the jet draws up with it air from the floor boundary layer.

Launches and Trial Trips

WAIKARE, cargo ship; built by Alexander Stephen and Sons, Ltd., for the Union Steam Ship Company of New Zealand, Ltd.; length 325ft, breadth 51ft, depth 26ft, deadweight 5090 tons, Costa Propulsion Bulb on rudder, three holds, twelve derricks and one to lift 25 tons; Stephen-Sulzer 6SD.60 diesel engine, six cylinders, 600mm diameter by 1040mm stroke, 3000 h.p. at 150 r.p.m., 2410 service h.p. at 128 r.p.m. Launch, July 17.

OVERSEAS EXPLORER, oil tanker; built by the Furness Shipbuilding Company, Ltd., for London and Overseas Tankers, Ltd.; length between perpendiculars 560ft, breadth moulded 80ft, depth moulded 42ft 3in, deadweight 24,800 tons on 32ft 4in summer draught, designed trial speed 14¼ knots; twenty-seven cargo oil tanks, one main cargo pump room, three 1000 tons per hour turbine-driven centrifugal cargo pumps, three 150 tons per hour vertical duplex stripping pumps; two 325kW turbine-driven generators, one 125kW diesel-driven generator; one set of Richardsons, Westgarths double reduction geared turbines, 7300 s.h.p. at 100 propeller r.p.m., steam at 450 lb per square inch and 750 deg. Fah. from two Foster-Wheeler "D" water-tube boilers. Launch, July 17.

L'ARDENT, coastal escort vessel; built by the Chantiers et Ateliers Augustin Normand for the French Navy; length overall 52·951m, breadth moulded 6·974m, mean draught 2·030m, displacement 380 tons, speed 18·7 knots, four 17.V.14.PA. Pielstick diesel engines drive two shafts, total power 3500 b.h.p. Launch, July 17.

STANCLOUD, oil tanker; built at the Neptune Works of Swan, Hunter and Wigham Richardson, Ltd., for the Stanhope (Overseas) Shipping Company, Ltd.; length between perpendiculars 535ft, breadth moulded 71ft 8in, depth 40ft, deadweight 18,300 tons on summer draught 29ft 6in, service speed 14 knots; thirty cargo oil tanks, one main cargo pump room, three 550 tons per hour steam-driven vertical duplex pumps, two stripping pumps; two 245kW diesel-driven generators, one 75kW steam-driven generator; Swan Hunter-Doxford oil engine, arranged to burn boiler fuel, six cylinders, 725mm diameter by 2250mm combined stroke, 7500 b.h.p. at 115 r.p.m. Launch, July 17.

ISLE OF ELY, short sea cargo ship; built by the Goole Shipbuilding and Repairing Company, Ltd., for the Eastern Region of British Railways, freight service Harwich to Rotterdam and Antwerp; length between perpendiculars 226ft, breadth moulded 37ft, depth moulded to shelter deck 23ft, deadweight 900 tons on 13ft 2in draught, service speed 13½ knots; hold capacity 85,000 cubic feet bale, space for forty-two "B" class railway containers, no cargo handling gear; MacGregor hatch covers; three 55kW diesel-driven generators; Ruston and Hornsby 8.VOXM diesel engine, 1806 s.h.p. at 425 r.p.m., modern wheel drive 2 : 1 reverse reduction gear. Launch, July 18.

DENBY GRANGE, oil tanker; built by Hawthorn Leslie (Shipbuilders), Ltd., for the Houlder Line, Ltd.; length overall 557ft, breadth moulded 72ft, depth moulded 39ft, deadweight 18,000 tons; twenty-seven cargo oil tanks, one main pump room, 12in diameter pipelines, 6in diameter stripping line; two 500kW geared turbo-alternators, 440V, 60 c/s, one 210kW diesel-driven alternator; one set of double reduction geared turbines, built by Hawthorn Leslie (Engineers), Ltd., 8250 maximum s.h.p., steam supplied at 500 lb per square inch and 800 deg. Fah. by two Foster-Wheeler "D" boilers. Trials, July 21, 22 and 23.

AMASTRA, oil tanker; built by Smith's Dock Company, Ltd., for Shell Tankers, Ltd.; length between perpendiculars 530ft, breadth moulded 69ft 3in, depth moulded 39ft, draught 29ft 6in, deadweight 17,800 tons, service speed 14½ knots; thirty-three cargo oil tanks, one main cargo pump room, four 400 tons per hour centrifugal Hayward, Tyler cargo oil pumps, two 200 tons per hour Dawson and Downie stripping pumps; two 400kW diesel-driven, 440V, 60 c/s, alternators, one 100kW steam-driven alternator; Hawthorn-Doxford two-stroke, supercharged oil engine, six cylinders, 650mm diameter, 7500 service b.h.p. at 112 r.p.m., 8000 maximum b.h.p. at 115 r.p.m., two Hawthorn Leslie-Babcock and Wilcox boilers. Trial, July.

Catalogues and Brochures

HEAD WRIGHTSON PROCESSES, Ltd., Teesdale House, 24-26, Baltic Street, London, E.C.1.—Illustrated brochure describing "Counterflo" induced draught cooling towers which were designed and developed by the Fluor Corporation, Ltd., of Los Angeles, U.S.A., and are manufactured and erected under agreement in the United Kingdom, the Commonwealth and the Sterling Area.

SANDERSON BROTHERS AND NEWBOULD, Ltd., Attercliffe Steelworks, P.O. Box 6, Newhall Road, Sheffield.—Booklet containing a summary of the standard brands of steel manufactured by the company.

B. O. MORRIS, Ltd., Morrisflex Works, Briton Road, Coventry.—Catalogue giving technical details and prices of pneumatic tools and accessories. Tools described in this list, ZA1, include drills, grinders and hammers. A complete catalogue with individual data sheets is available on request.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., 21, Bloomsbury Street, London, W.C.1.—Publication No. 396 describing B.I.C.C. feeder pillars, standard and dwarf types.

Q.V.F., Ltd., Duke Street, Fenton, Stoke-on-Trent, Staffs.—Illustrated catalogue describing "Visible Flow" glass sink traps and waste lines, fabricated in chemically resistant boro silicate glass.

Advanced Engineering Courses

Post-Graduate Course in the Metallurgy of Nuclear Power Materials. DEPARTMENT OF METALLURGY, COLLEGE OF TECHNOLOGY, Birmingham. Ten lectures intended for technical staff engaged in research and development on nuclear reactors, and for students proceeding to advanced metallurgy examinations, to be held on successive Tuesday evenings, starting October 7. Fee 2 guineas.

Post-Graduate Course in Spectrographic and Chemico-Physical Analytical Techniques for Metallic Materials. DEPARTMENT OF METALLURGY, COLLEGE OF TECHNOLOGY, Birmingham. Twelve lectures intended for metallurgists and chemists engaged in research and development work to be held on successive Wednesday evenings starting October 8. Fee 2 guineas.

Electronic Switching. DEPARTMENT OF ELECTRICAL ENGINEERING AND APPLIED PHYSICS, SOUTH EAST LONDON TECHNICAL COLLEGE, Lewisham Way, London, S.E.4. Course of six lectures to be held on Tuesday evenings commencing October 21, 7 p.m. to 9 p.m. Enrolment from September 16 onwards. Fee 10s.

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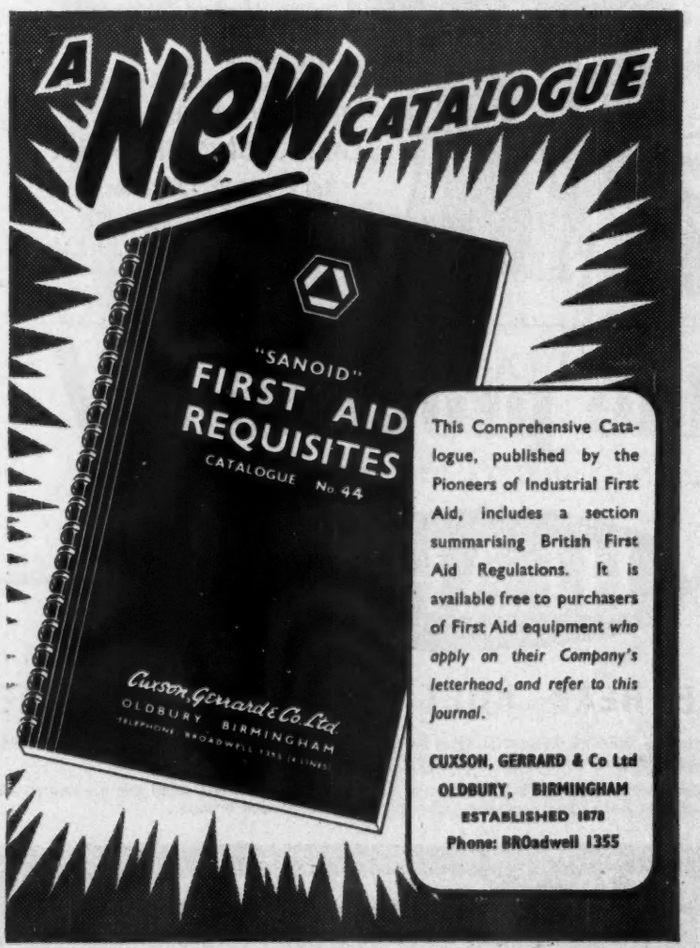

This Comprehensive Catalogue, published by the Pioneers of Industrial First Aid, includes a section summarising British First Aid Regulations. It is available free to purchasers of First Aid equipment *who apply on their Company's letterhead, and refer to this Journal.*

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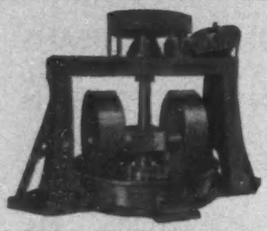

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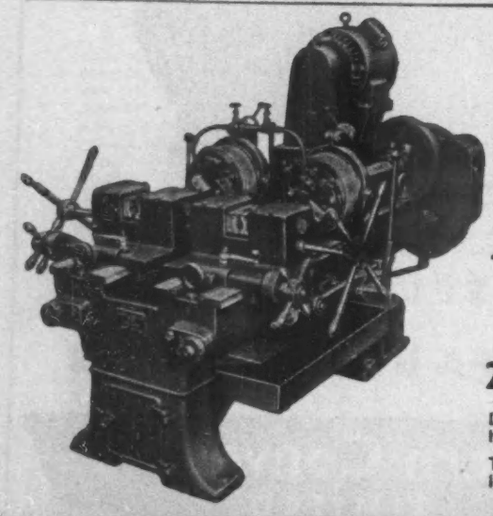

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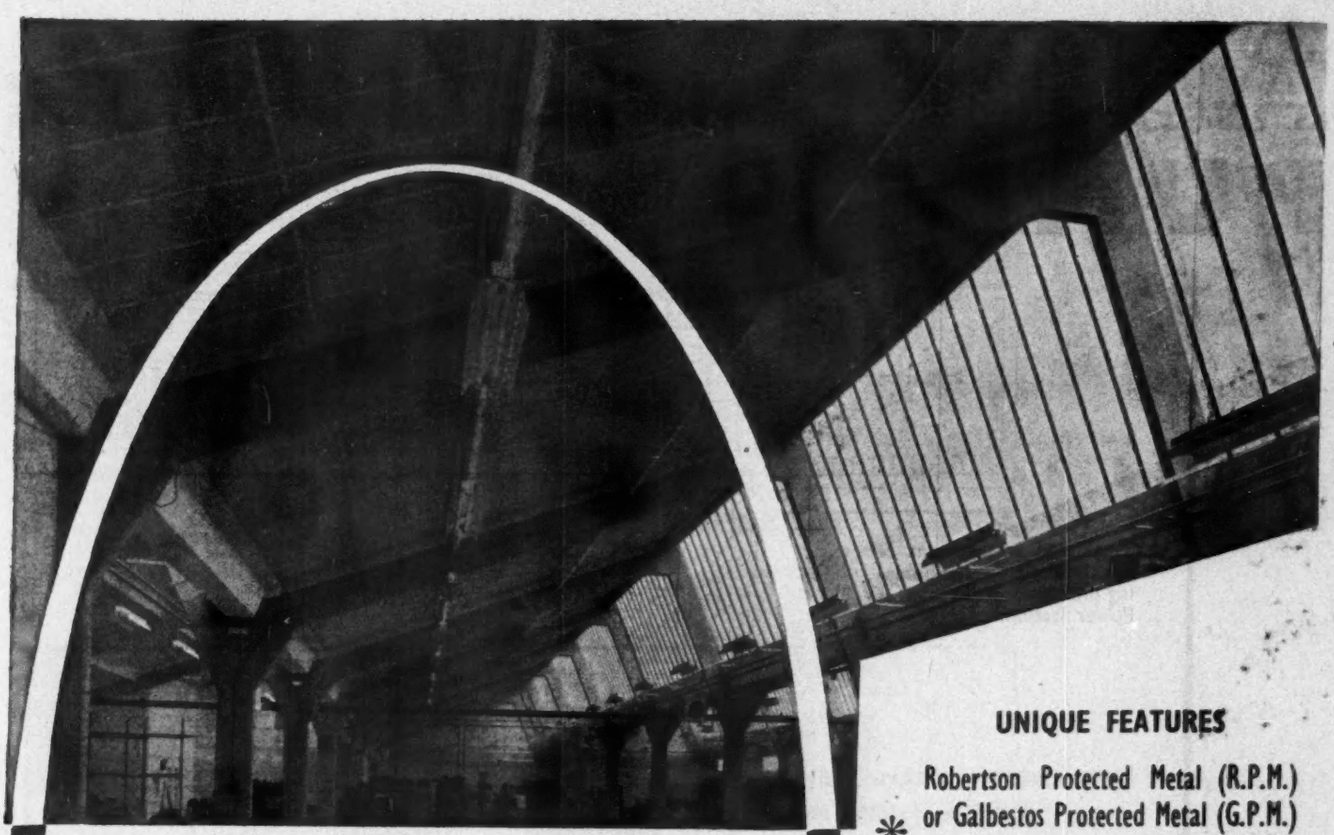

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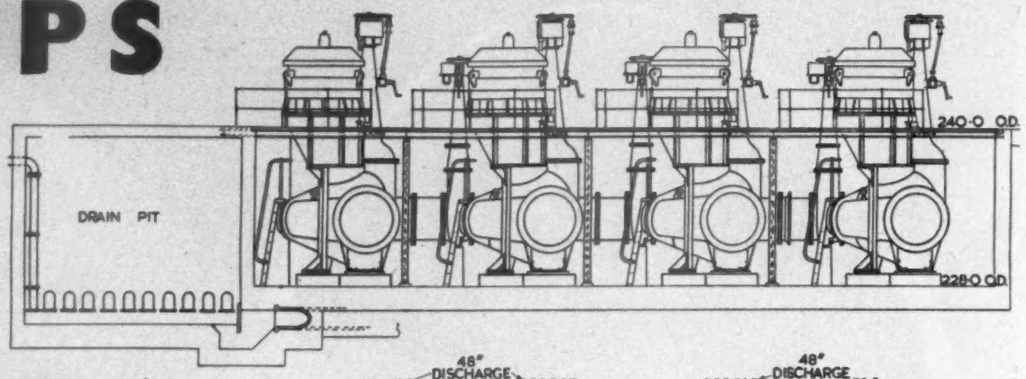
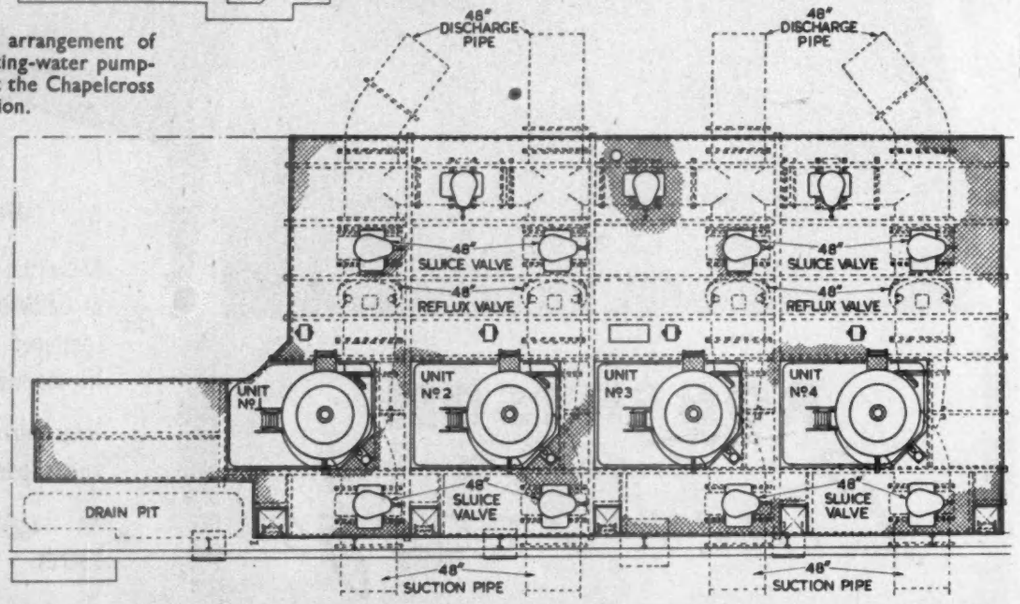


Installation arrangement of the circulating-water pumping units at the Chapelcross Power Station.



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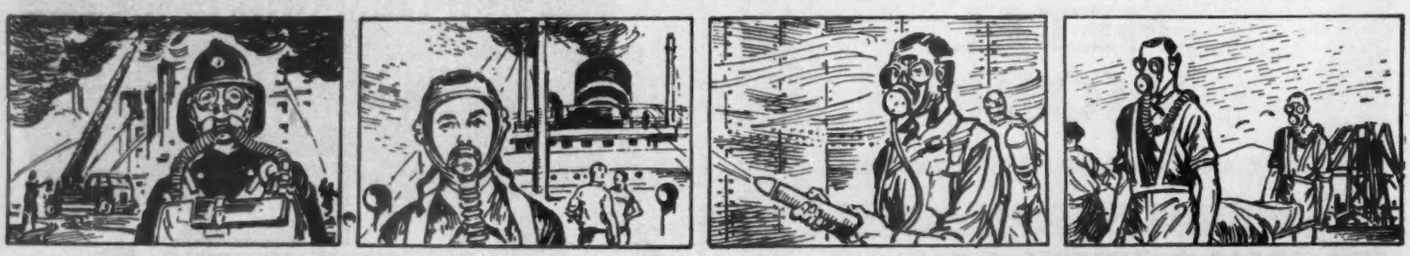

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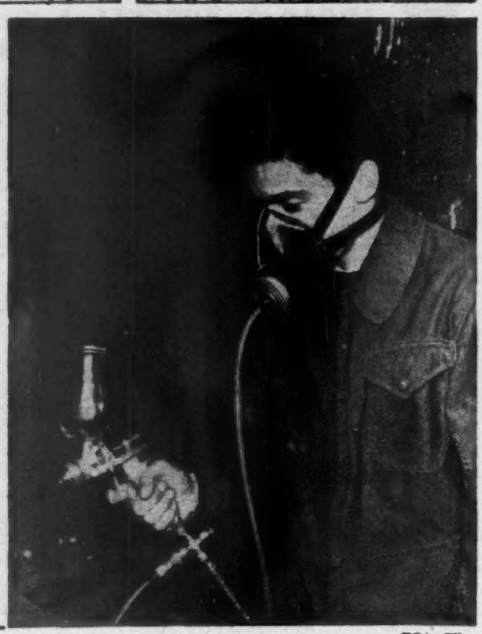

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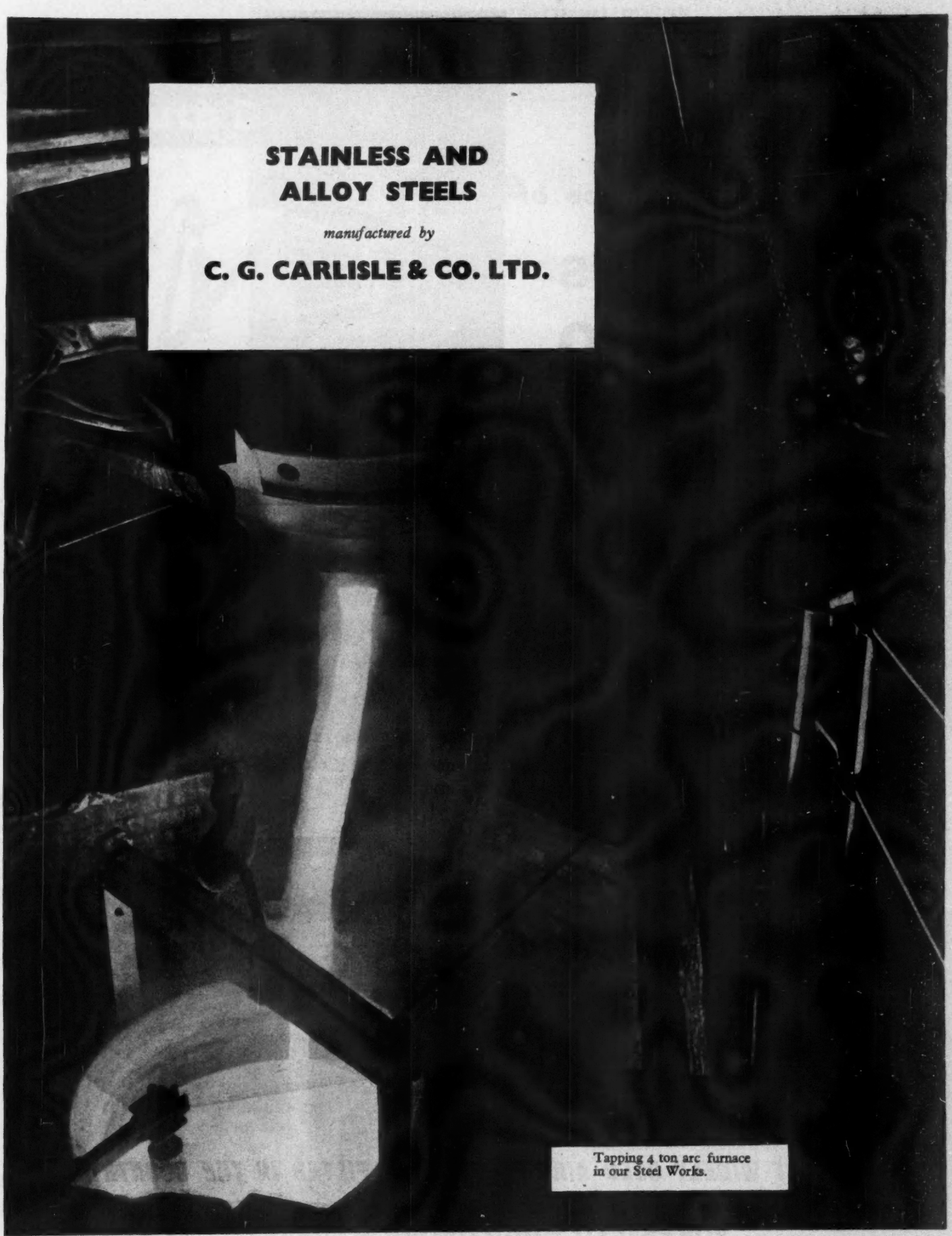

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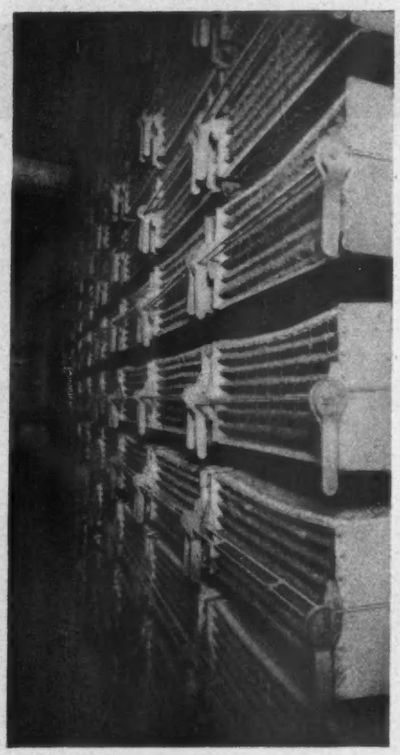

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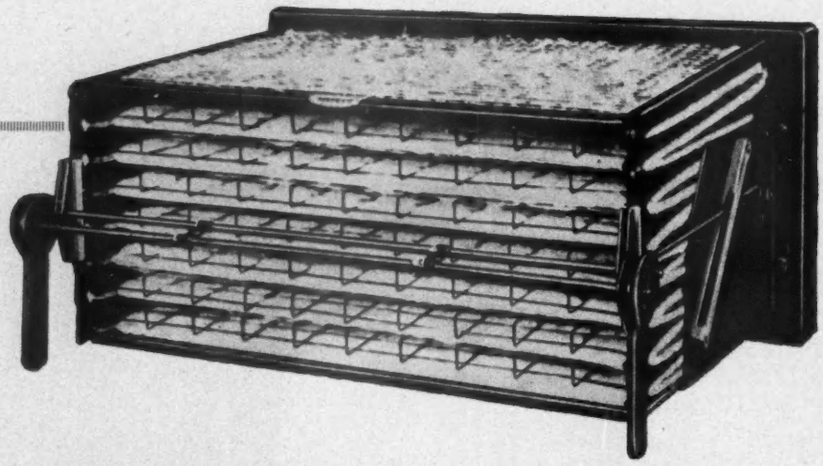

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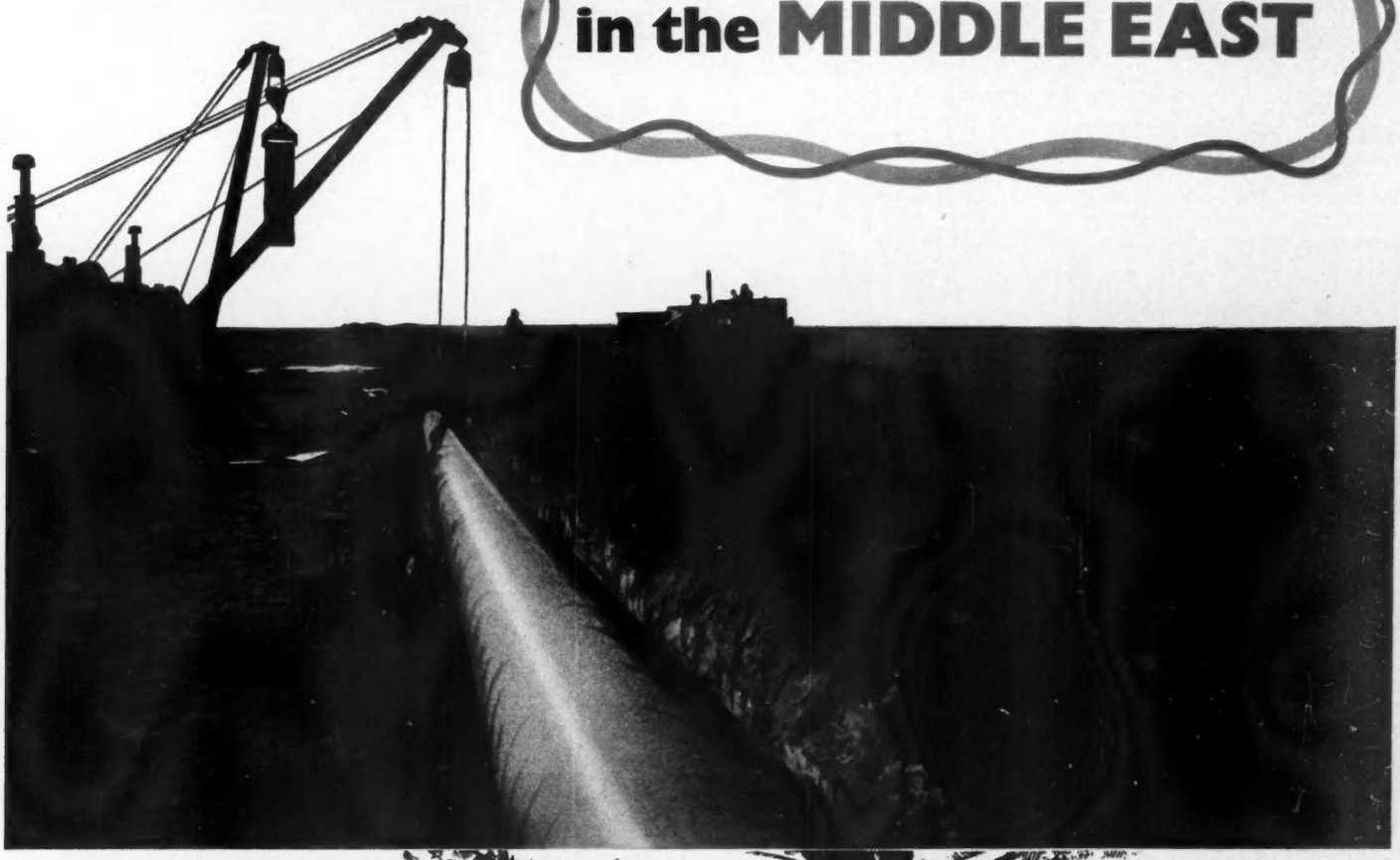

Illustration shows construction in progress on the Basrah Petroleum Company's 65-mile pipeline which now delivers oil from the Zubair and Rumaila fields to the terminal at Fao at the mouth of the Shatt-el-Arab River.

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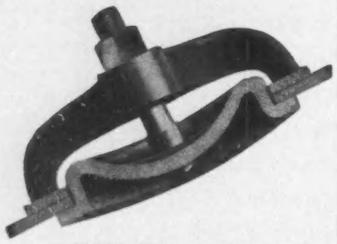

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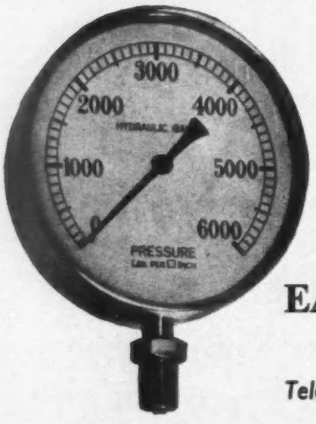

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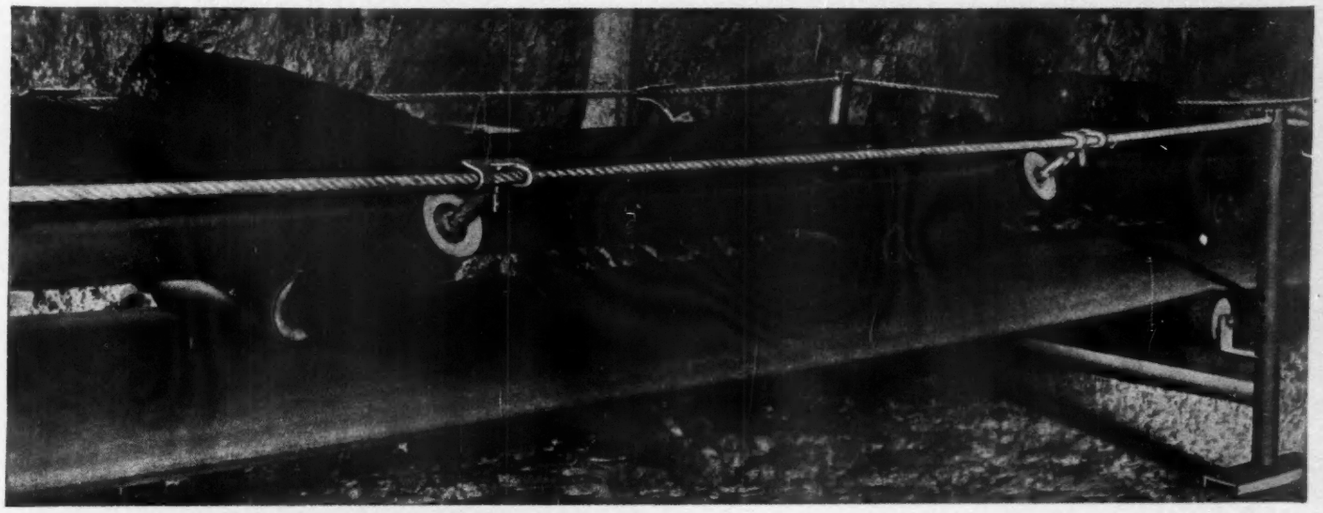

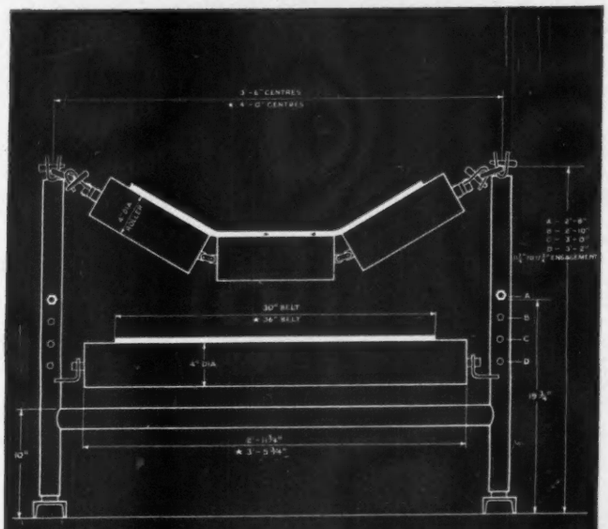

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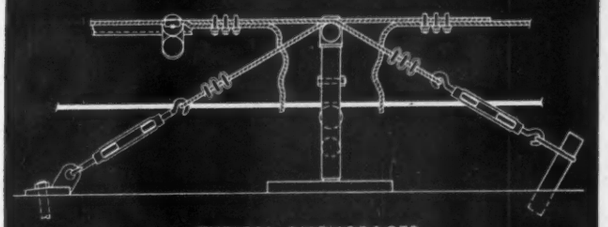

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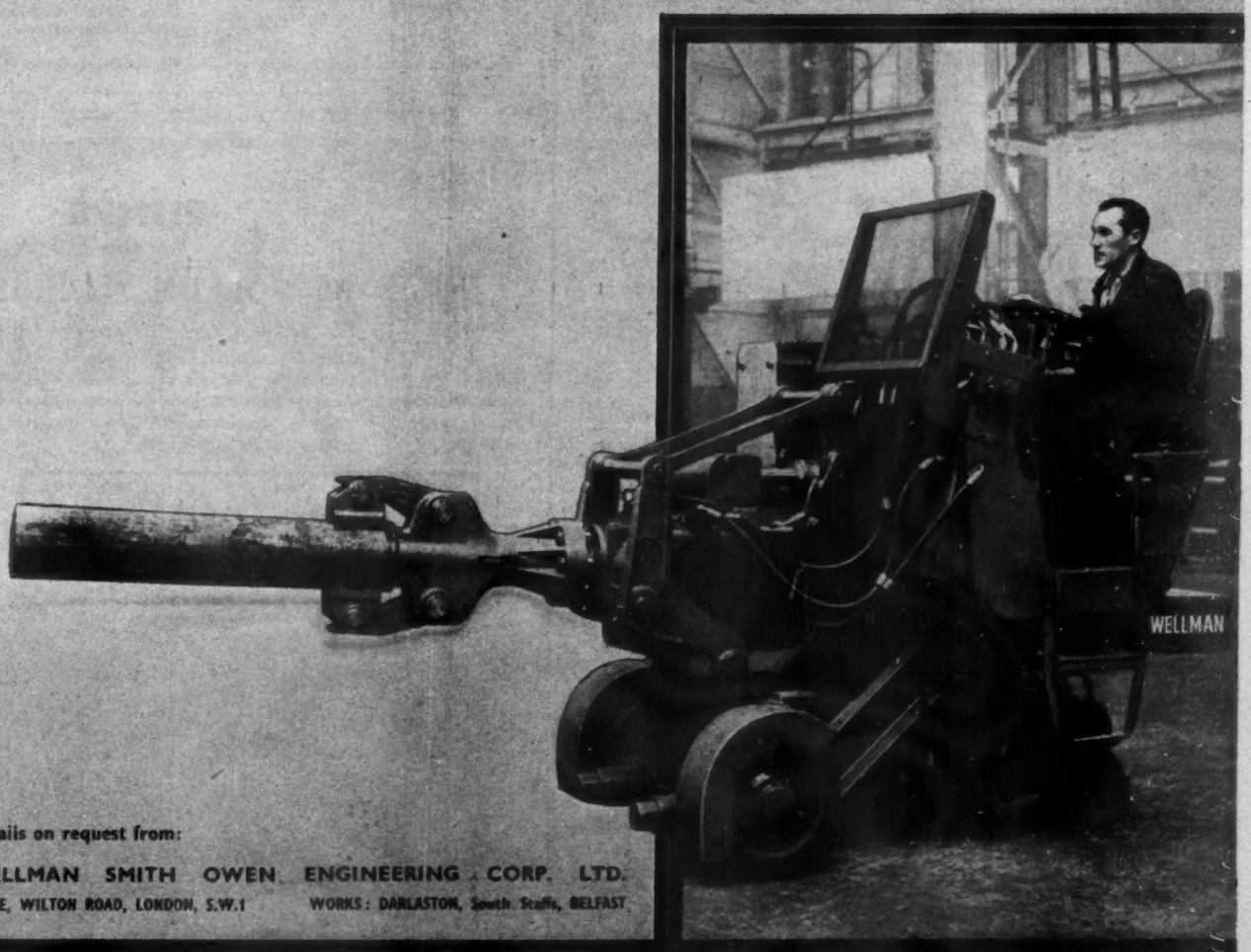

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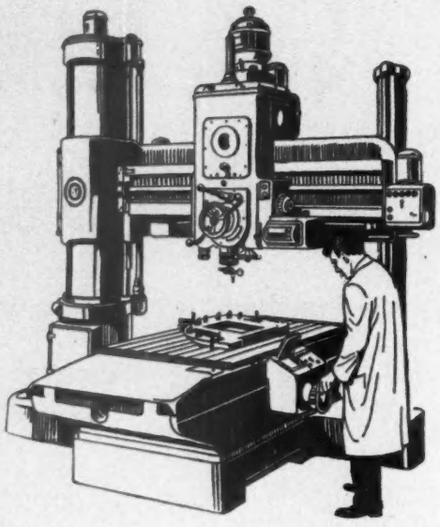

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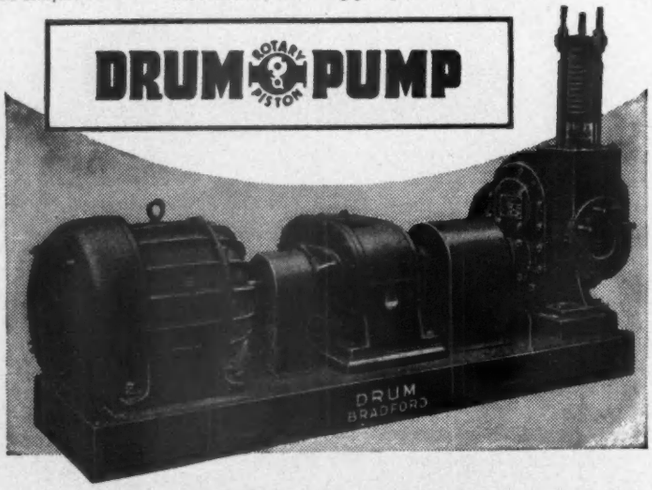

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HUMBOLDT STREET, BRADFORD. TELEPHONE: BRADFORD 22358
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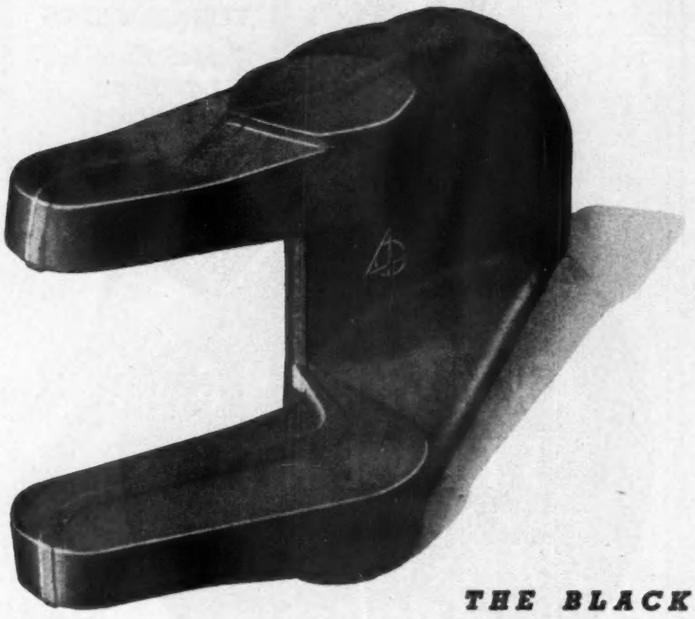
Superior

DROPFORGINGS DROPFORGINGS DROPFORGINGS DROPFORGINGS



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BLACKHEATH · BIRMINGHAM Phone Blackheath 1448/9

Unique

"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.

C. P. Newall & Co., Ltd.

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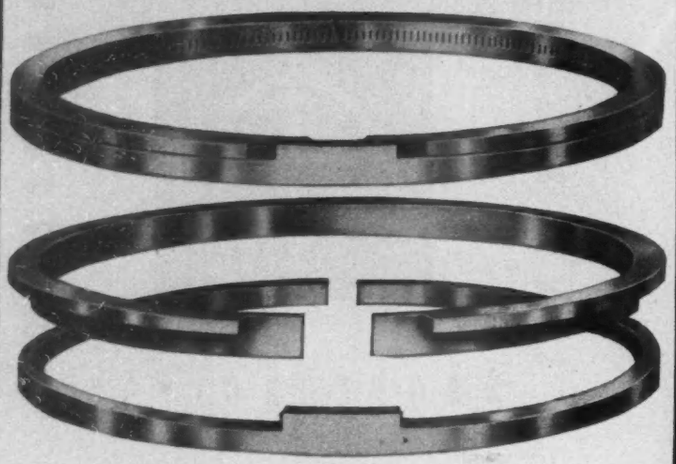
STANDARD'S TRIPLE SEAL PISTON RINGS



EFFECTIVELY SEAL THREE FACES

Eliminate by-pass, Restore compression, Maintain full power, Function until bore of cylinder is worn by as much as 1%.

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Tapped Right and Left Hand Whitworth Threads.

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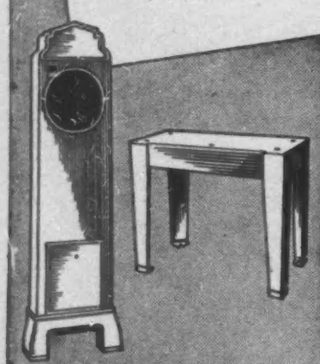
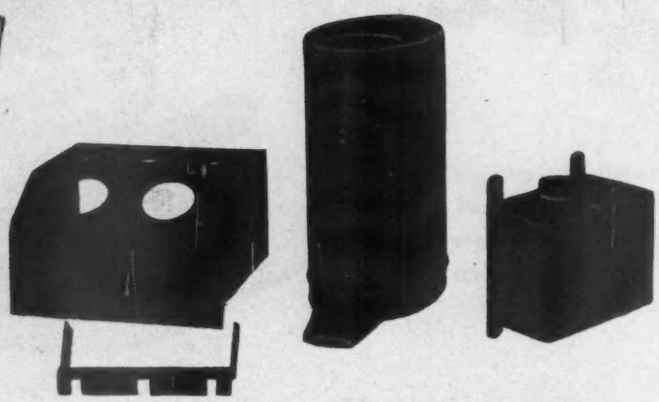
Sheet Metal Workers of Repute

Established 1857

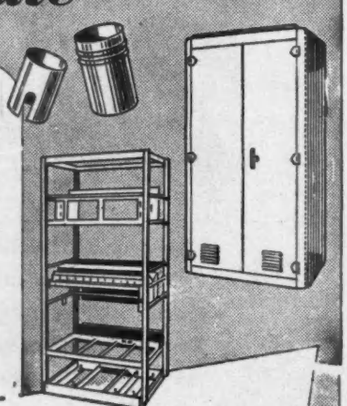
We have modern plant and 100 years Experience which enables us to carry out a great variety of work and meet all needs.



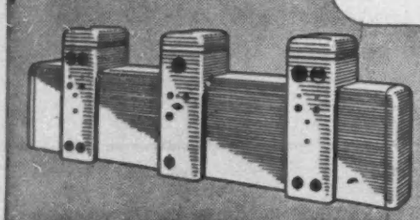


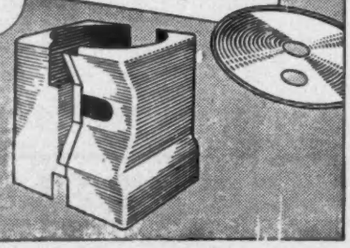
Examples of general sheet metal work shown here comprise an Air Compressor Control Panel, a High Pressure Grease Dispenser, and on the right, an Oil Tank used for the automatic lubrication of commercial vehicles.

Contractors to Admiralty, Ministry of Supply and G.P.O.



Well-equipped tool-room for the manufacture of the necessary tools to your designs or our own.





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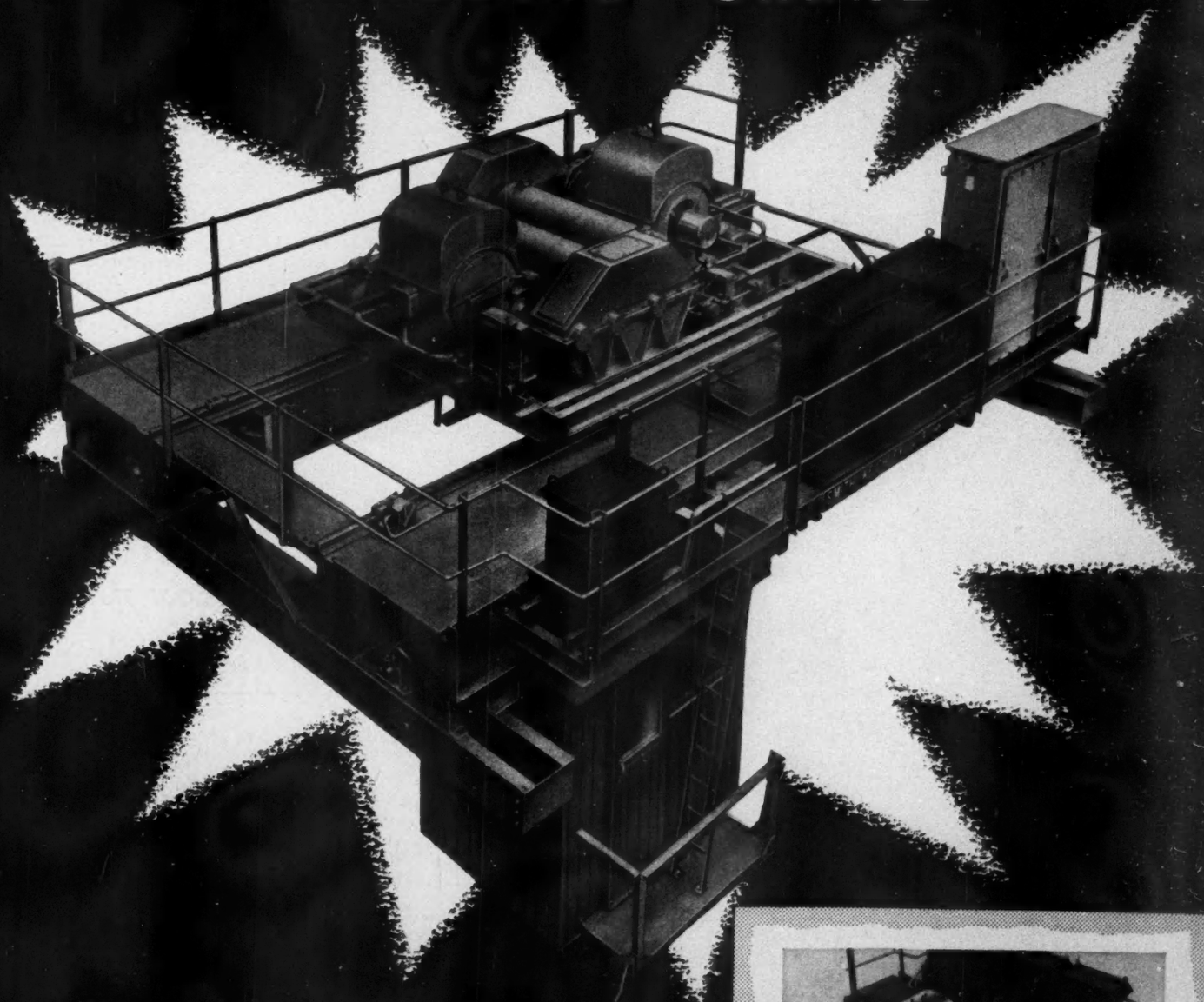
OVERHEAD

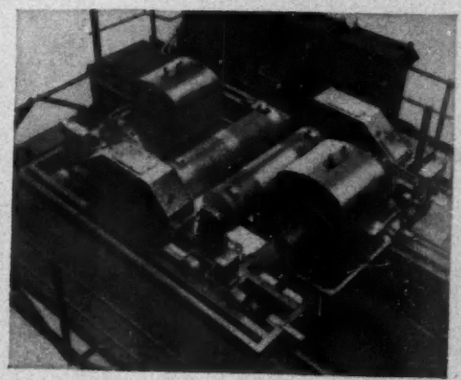
GRABBING CRANE



This crane is one of two specially designed for heavy duty grabbing service in one of the new super power stations. The Cranes are operating in the open, and special attention has been given to weather-proofing and positioning of the units for easy access.

If you have a handling problem—call in

John Smith CRANES



The Crab

The Crab is of the twin barrel type, having one barrel for "holding" and one for "opening" and "closing" the four rope Grab. All gear boxes are of steel fabricated welded construction.

JOHN SMITH (KEIGHLEY) LTD.

P.O. BOX 21, THE CRANE WORKS, KEIGHLEY, YORKS.

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Series 500 and series 700 A.C. Solenoids are available in Flame Proof enclosing cases, certified to Buxton standards.

Your production processes can be made more efficient by fitting Westool Solenoids to your machines. Why? Because Westool Solenoids are compact, self-contained electro-magnetic units which provide a direct mechanical action automatically or by remote push-button control. No gear trains, no complicated mechanisms—just simple electrical wiring from the control panel to the "on-the-spot" Solenoid actuator. Westool Solenoids lift, lower, push, pull, open or shut, and thus simplify machine designs, speed up operations and reduce production costs. There is a long and diverse list of machinery which has already been improved by solenoid control—you can add yours to the list with advantage.

To meet customers' immediate requirements, Westool carry some 10,000 solenoids of various types and ratings so that your immediate needs may be dealt with by return.

Write to the Westool Technical Advisory Service—it's your first step in a production speed-up.

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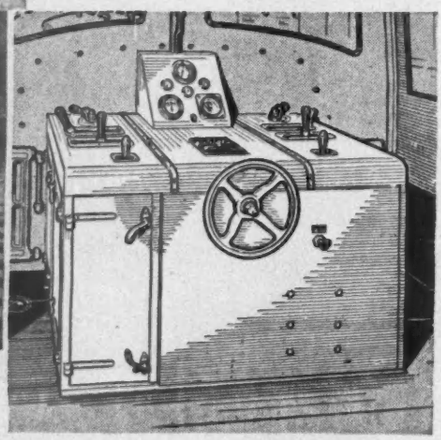
TIB 94

for simplicity... *of control...*

The controls of the Peckett Diesel Locomotive are easy to handle—no special manipulation of throttle or clutch is required for gear changing.



PECKETT diesels

The various control levers have been carefully grouped for maximum convenience and are duplicated on either side of the control desk. In conjunction with the extraordinary all-round vision from the fully-enclosed cab, this simplicity greatly minimizes fatigue and mental distraction, and ensures the fullest output from driver and locomotive.

London Representatives:
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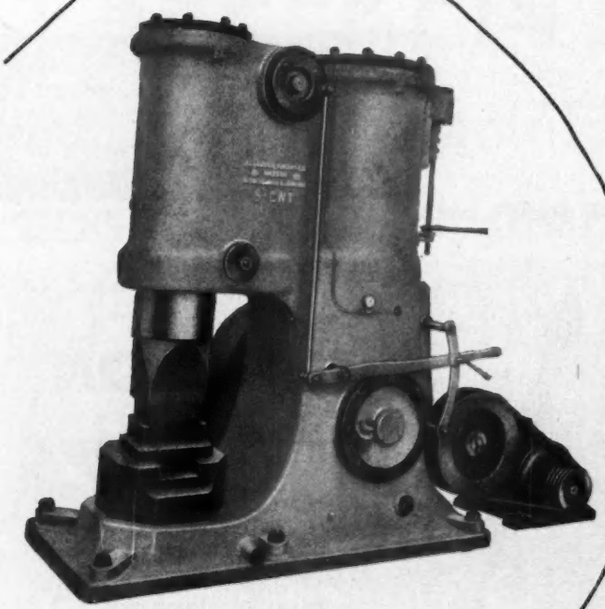
PECKETT & SONS LIMITED, ATLAS LOCOMOTIVE WORKS, ST. GEORGE, BRISTOL 5. Tel: 65-5346. 'Grams: "Peckett" Bristol

The Hall Mark tells a story . . .

For 650 years these marks have provided a unique guarantee of maker, quality, origin and date. Shown below are those which would appear on an article made by Zedd and Co. Ltd., from Britannia Silver (indicated by the figure of Britannia) made in Birmingham (the Anchor) in 1950 (the letter 'A' drawn a particular way).

CO Z LTD



This mark is also an accepted world standard of quality in engineering; foremost in design and efficiency. From the wide range of Alldays and Onions products we show you here the P.B. HAMMER.

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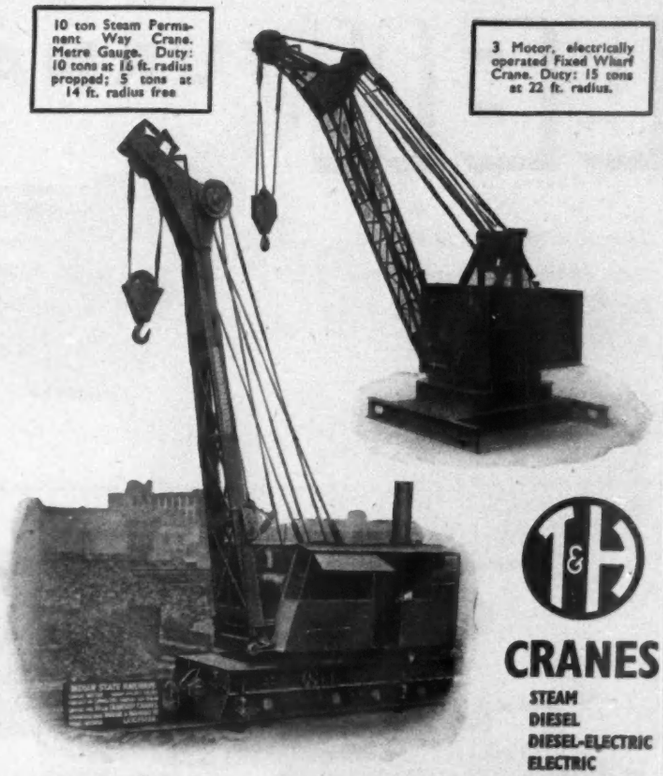

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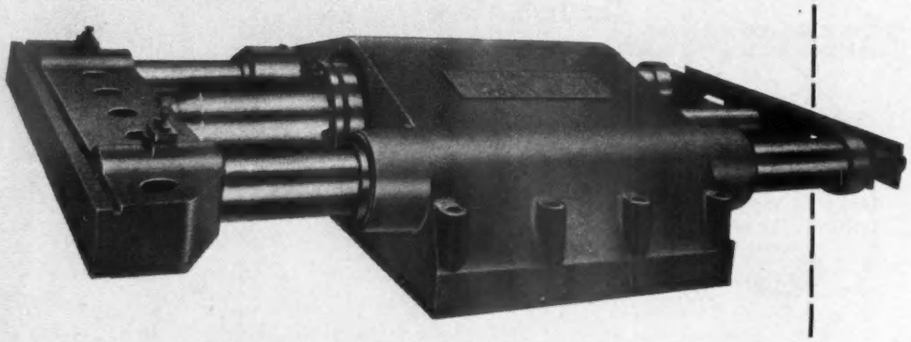
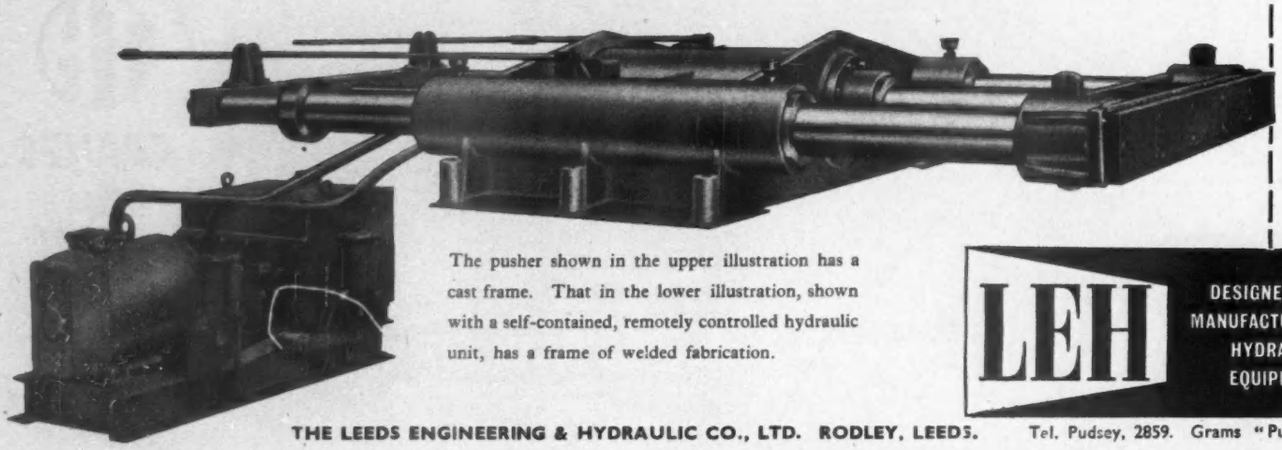
LEH FURNACE PUSHERS

Typical of robust L.E.H. design, these hydraulic furnace pushers are ideally suited to steelworks duty where unfailing reliability under arduous conditions is of prime importance.





The pusher shown in the upper illustration has a cast frame. That in the lower illustration, shown with a self-contained, remotely controlled hydraulic unit, has a frame of welded fabrication.

LEH DESIGNERS AND MANUFACTURERS OF HYDRAULIC EQUIPMENT

THE LEEDS ENGINEERING & HYDRAULIC CO., LTD. RODLEY, LEEDS. Tel. Pudsey, 2859. Grams "Pumps," Rodley.

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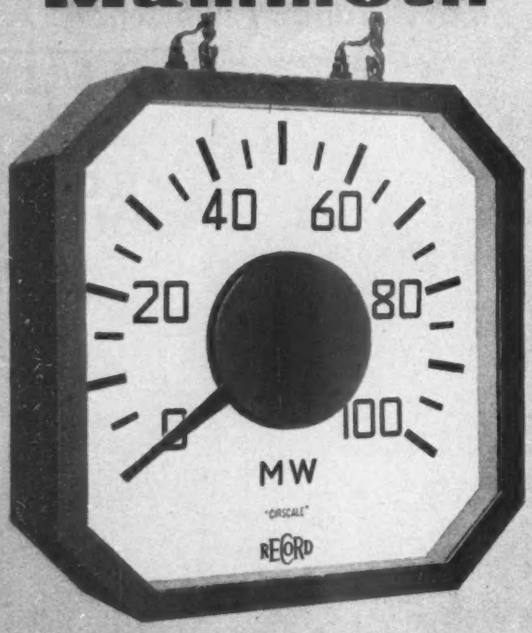

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With a scale length of 5 feet, bold figures and internal illumination, this instrument can be read accurately at considerable distances. It complies fully with BSS 89/1954 and combines ample power with high sensitivity. It is suitable for indicating Amps, Milliamps, Volts, R.P.M. or Frequency, or any value which may be converted into one of these. Single or double sided models available

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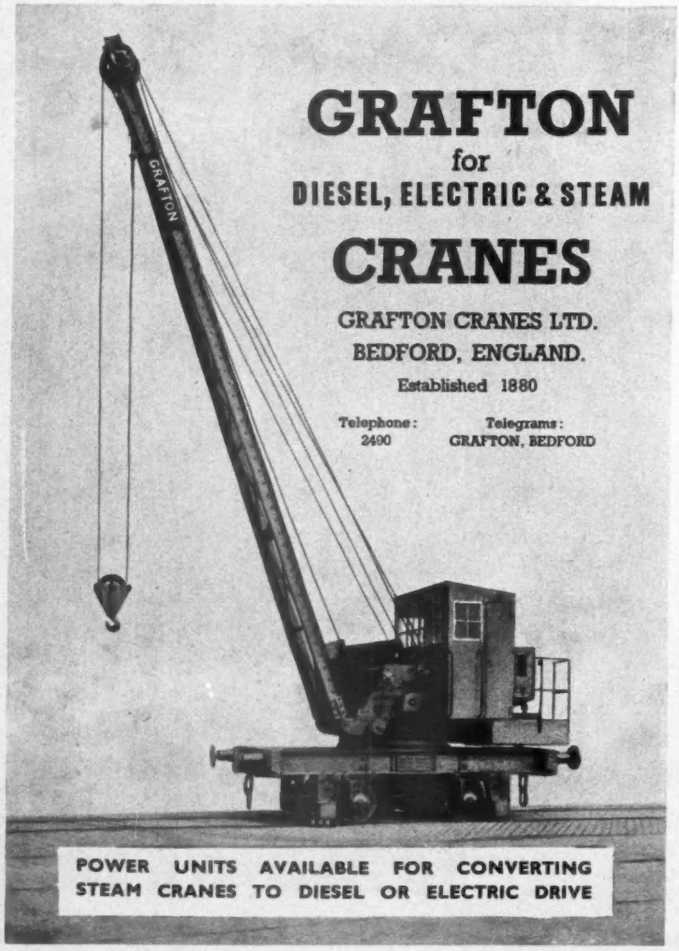

GRAFTON
for
DIESEL, ELECTRIC & STEAM
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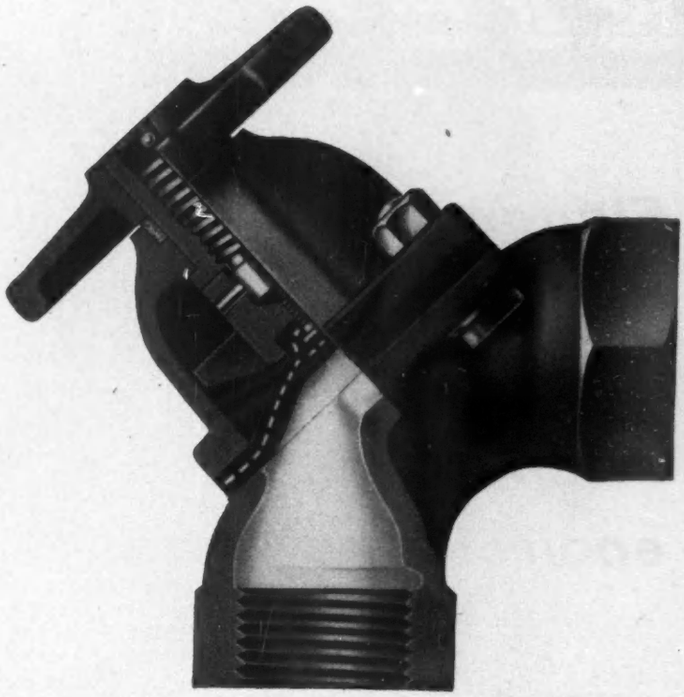
POWER UNITS AVAILABLE FOR CONVERTING STEAM CRANES TO DIESEL OR ELECTRIC DRIVE



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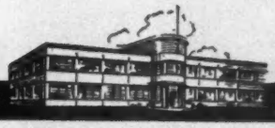
- - - to perform simple duties more EFFICIENTLY

SAUNDERS DIAPHRAGM VALVES

Acknowledged universally for their superiority in handling the difficult fluids of industry — the sureness of that flexible diaphragm closure and the long, trouble free life commend the valves also for scores of simple duties.

TO AVOID WASTAGE OF WATER, AIR, GASES AS WELL AS THE STILL MORE COSTLY FLUIDS OF INDUSTRY



SAUNDERS VALVE COMPANY LIMITED

DIAPHRAGM VALVE DIVISION

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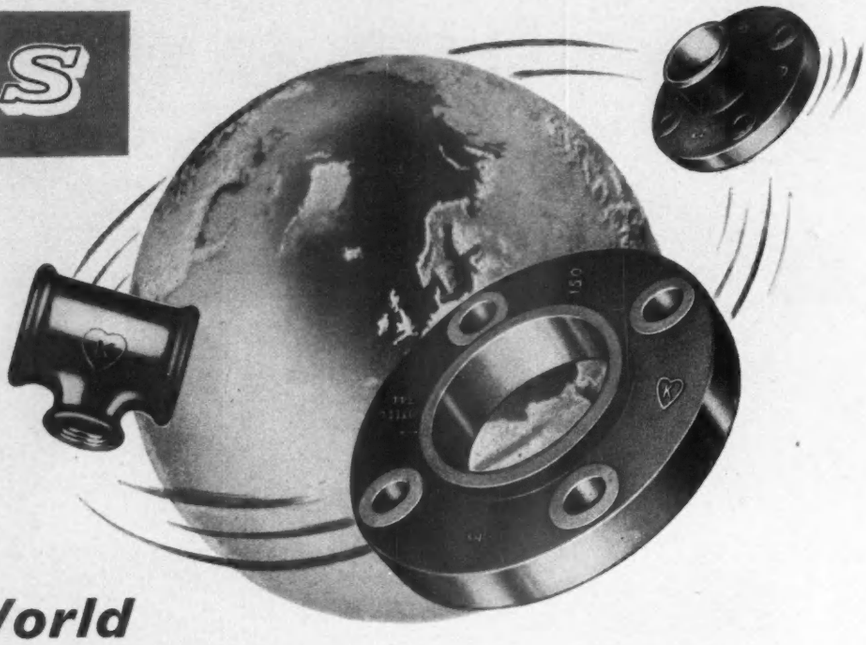

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Our flanges, pipework and malleable fittings are in use all over the Globe.

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Finer, Faster and Quieter Milling with the Linatex Ball Mill

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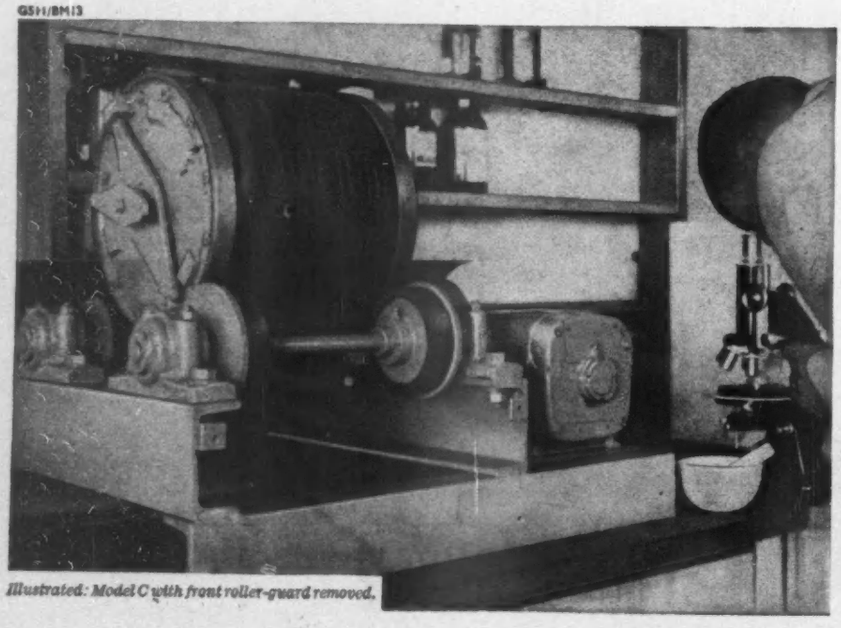


Illustrated: Model C with front roller-guard removed.

Linatex Ball Mills owe their unique working efficiency to drum walls of solid Linatex —95% pure natural rubber —which defies abrasive and corrosive action.

It is worth noting that experimental results obtained in pilot plant equipped with this Linatex Laboratory model can be reproduced accurately on the production line by using the larger works' models. Full details in the Linatex Ball Mill brochure—sent free on request.

Consider these advantages:

Quicker grinding time and a fine particle.

No metal exposed internally.

No risk of contamination.

Six types available to suit different production requirements.

Our Resident Engineer for your area is always ready to discuss, and help solve, your Ball Milling problems.

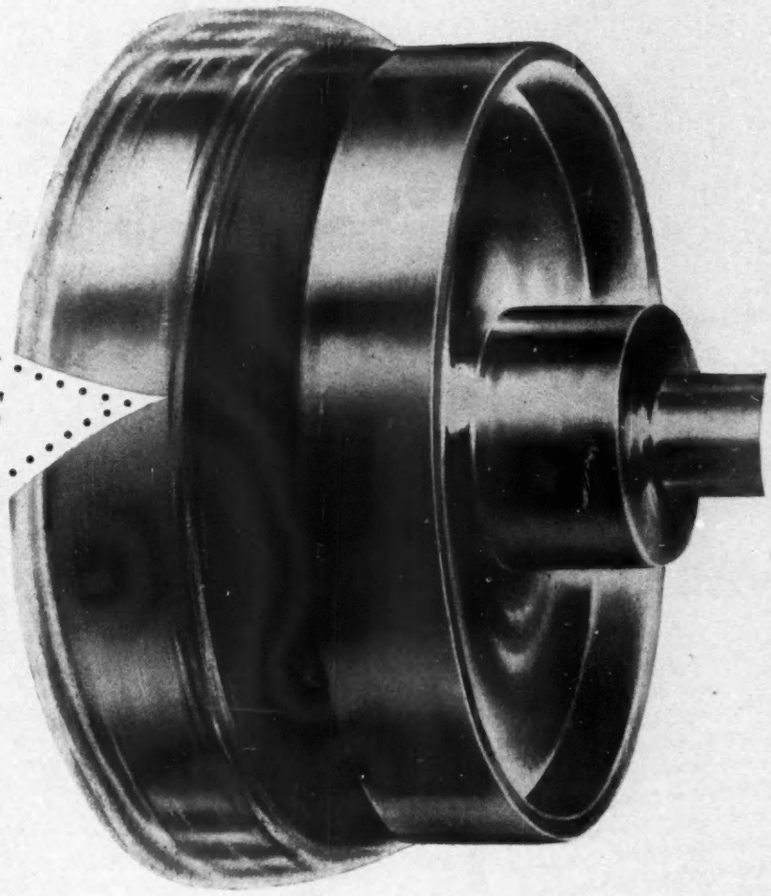
LINATEX

95% PURE NATURAL RUBBER

BALL MILL WITH LONGER LIFE

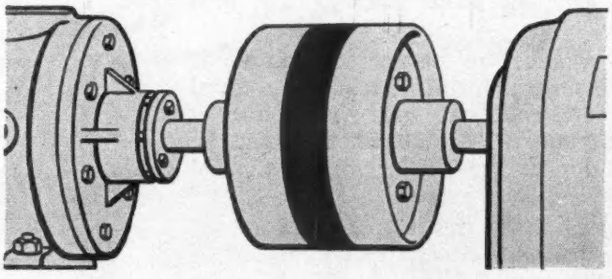
WILKINSON RUBBER LINATEX LIMITED
CAMBERLEY SURREY. Phone: Camberley 1595

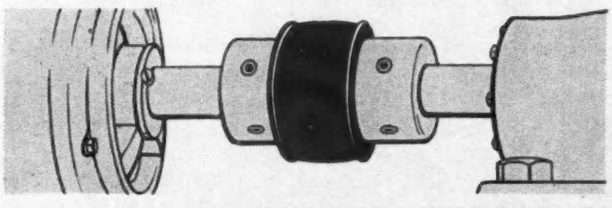
NO LOSS OF EFFICIENCY HERE through vibration or 'whip'



When machines must operate
under load fluctuation
or conditions of misalignment

DUNLOP *FLEXIBLE COUPLINGS HELP SMOOTH WORKING*





Dunlop Couplings consist of flexible rubber elements bonded to metal ends. The rubber can be compounded with varying degrees of stiffness as required by the task the coupling has to do, but the physical properties are always controlled within fine limits. Dunlop Flexible Power Transmission Couplings can be used with confidence in applications where precision is vital.

DISC COUPLINGS
For heavier equipment, operating at up to 96 h.p. per 100 r.p.m.

BARREL COUPLINGS
For light machines and motors, operating at up to 0.54 h.p. per 100 r.p.m.

For any problem in precision rubber engineering

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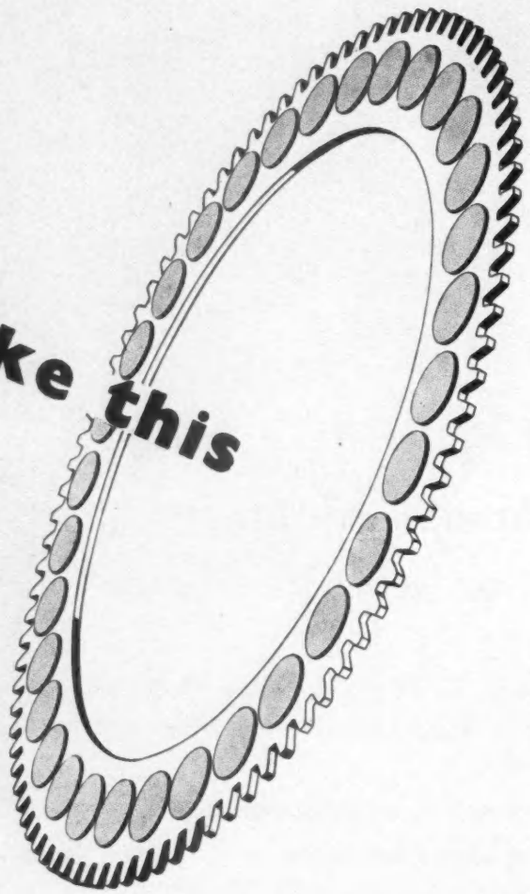
EDC/PC3

you see—it's like this



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Morgan SINTERLINK has indeed got friction buttoned up. In a way that is of extreme importance to the designer, the manufacturer and the user of all heavy duty machinery that incorporates a clutch.

And now SINTERLINK faced clutch plates are available in a unique "button" design that makes for even greater gripping power and quicker heat dissipation.

SINTERLINK, whether in button or continuous form, is made from sintered metal. Because it is metal it will not only *withstand* heat, but will conduct it away as well. Because it is sintered, it brings to clutches infinitely longer life—under even the most punishing conditions.

Some printed matter about this is available, or one of our technical representatives will quickly respond to a 'phone call or letter.

MAXIMUM MARKS TO SINTERLINK FOR
Low Rate of Wear—Smooth operation
Stability—Absence of Fade
High Thermal Conductivity.

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CABLES

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LIMITED
STAINES, MIDDLESEX
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You'd raise a doubtful eyebrow...

If told that removing grease and oily deposits was a simple job, you'd think of those filthy bits of cotton waste and splodges of dirty grease and sigh and sadly shake your head. But you'd be wrong. GUNK has solved all degreasing problems and does the dirty work for you. Simply brush on GUNK—then hose or rinse off with water. As if by magic all traces of grease and oil disappear. There's nothing finer for the speedy removal of dirt, grime, grease, oil and sludge.

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THE WORLD'S FINEST

DEGREASANT

Supplied ready for use in 5-, 10- and 40/45-gallon drums. Send to-day for a free sample and prove for yourself the effectiveness of GUNK.

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BOSTON MILLS, HYDE, CHESHIRE
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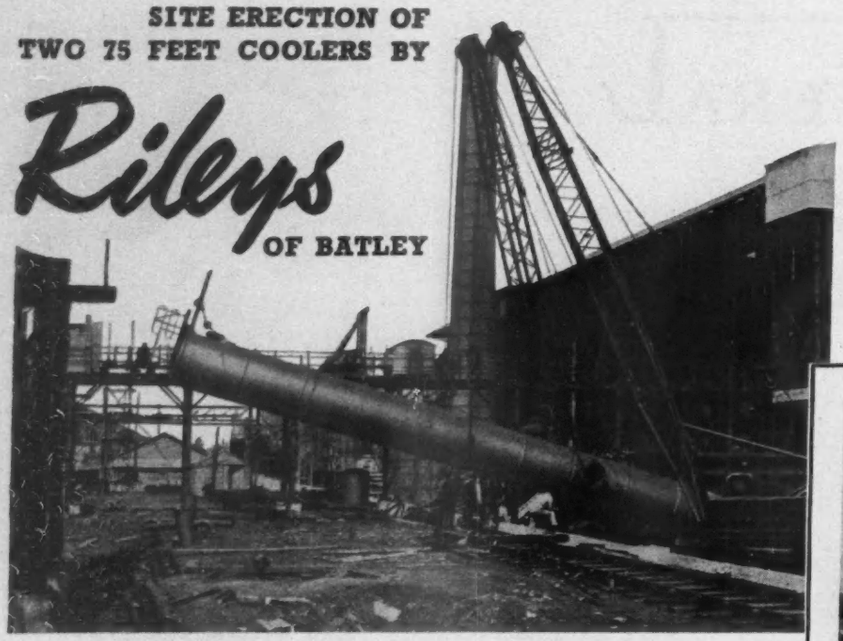
SITE ERECTION OF TWO 75 FEET COOLERS BY

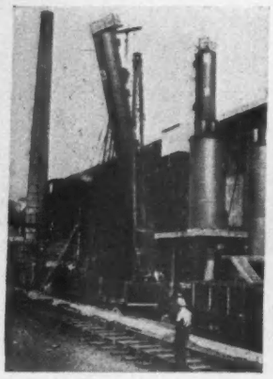
Rileys OF BATLEY

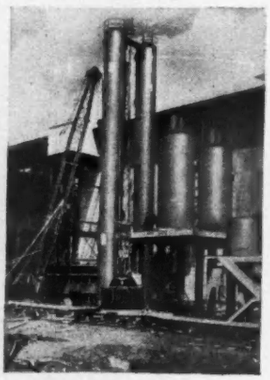


EACH cooler left our works in three sections. The sections were welded together on the site prior to the coolers being lifted into their final vertical positions.

We manufacture Pressure Vessels, Columns, Coolers, Heat Exchangers, Condensers, Silos, Storage Vessels, Tanks, Mains, Autoclaves, Digestors, Mixers, and supply associated equipment such as pipe and valve work, pumps, electrical equipment, instruments, etc.

Stainless Steel work, and welded and rivetted general fabrications are other specialities.





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opposed piston

turbo charged engine

Six cylinders. 650 mm bore.
2,320 mm combined stroke.
115 r.p.m. 8,000 b.h.p. 8,700 i.h.p.
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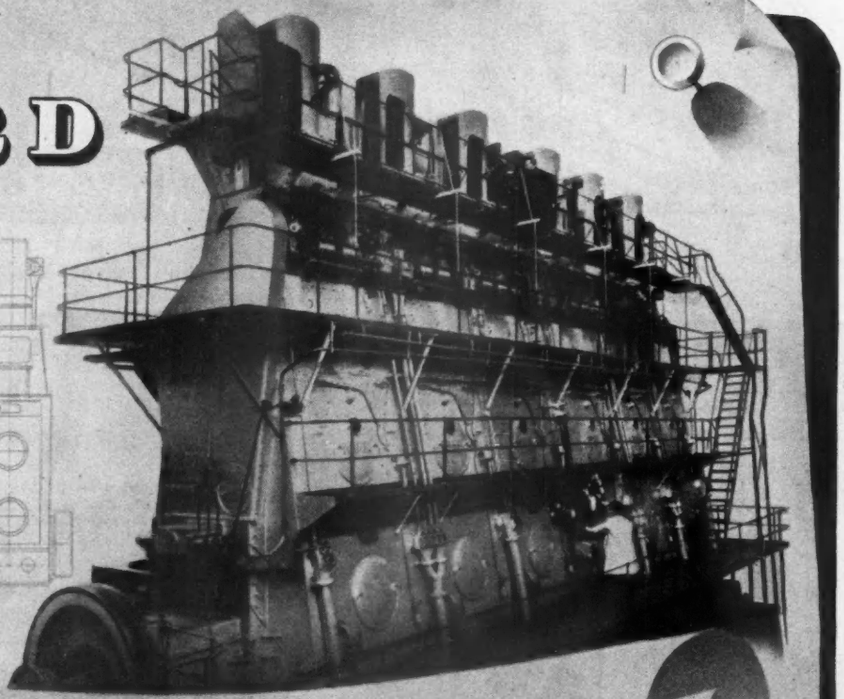

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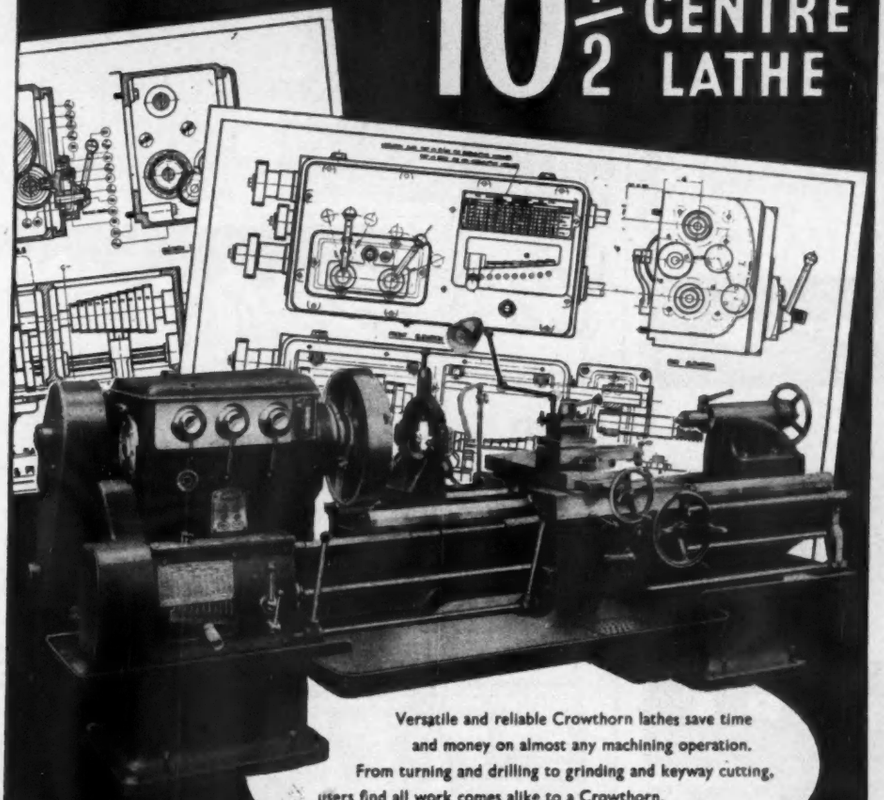

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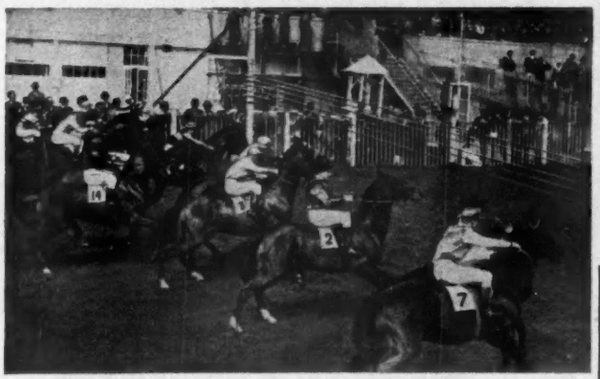

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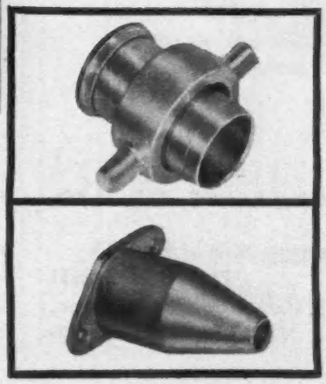

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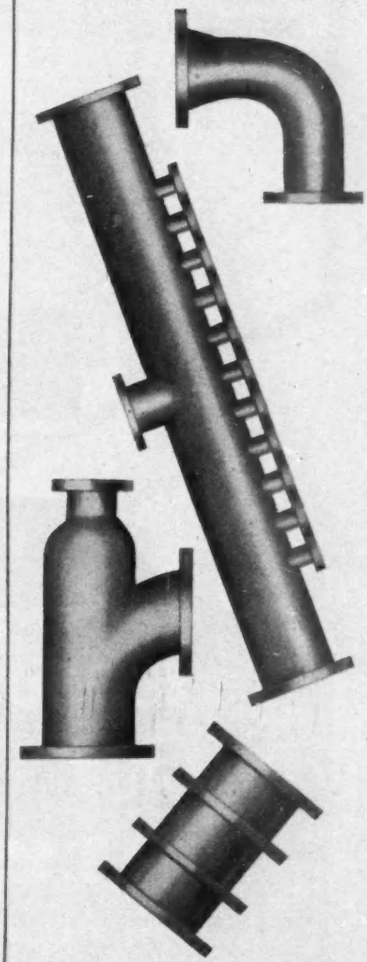

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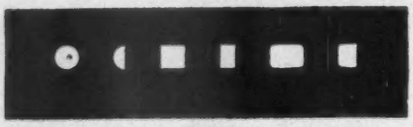

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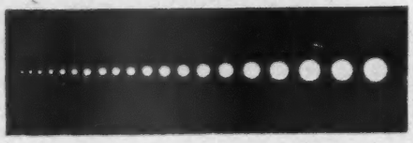

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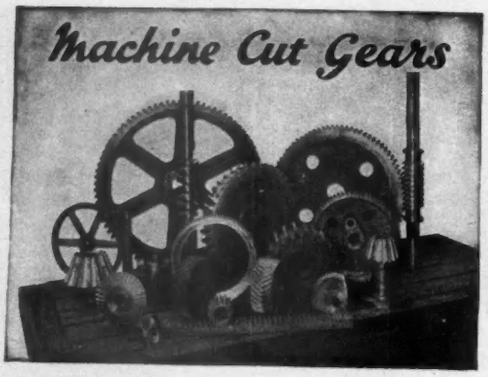

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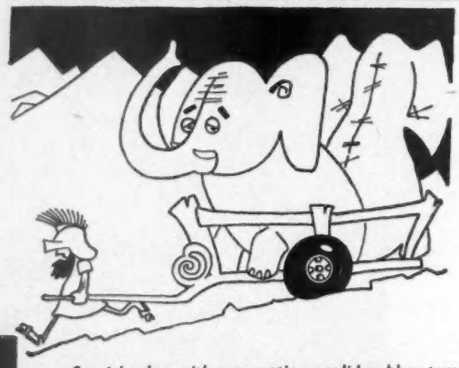

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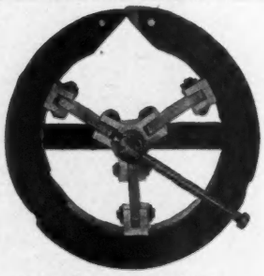

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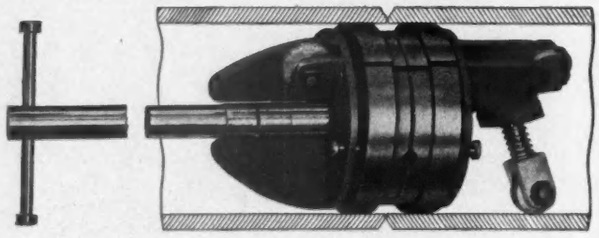

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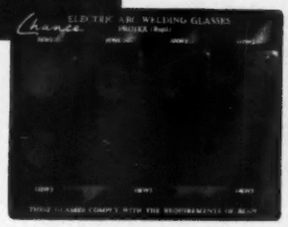

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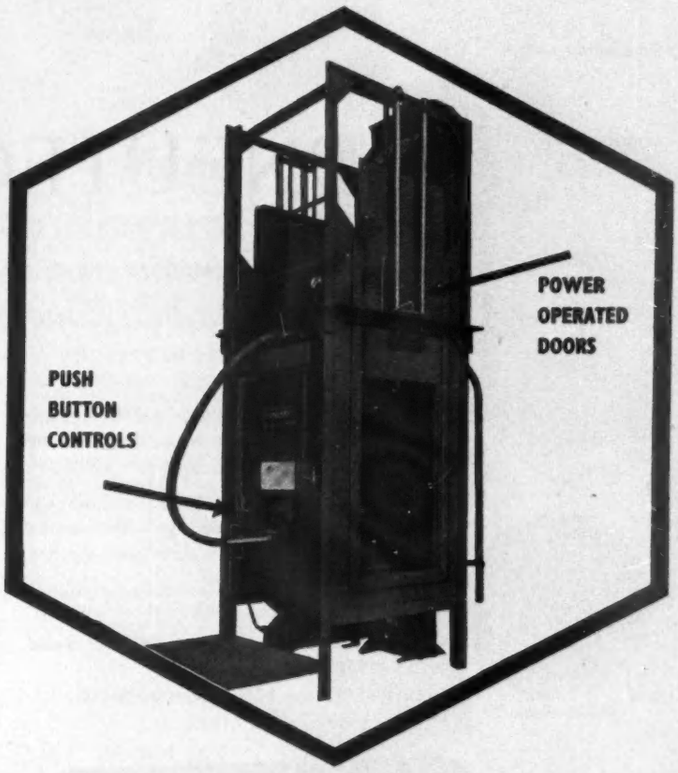

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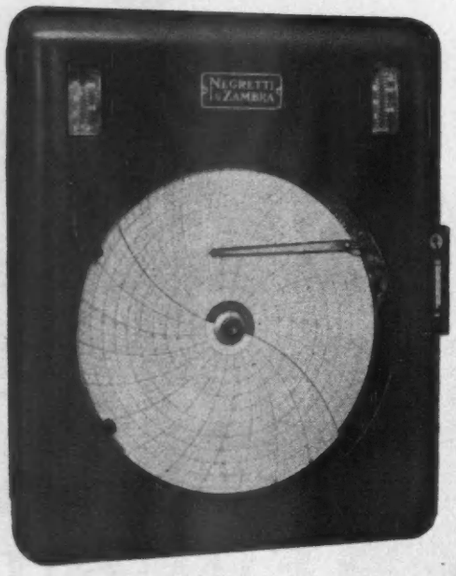

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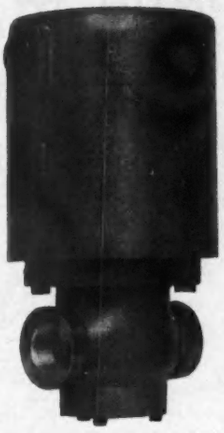

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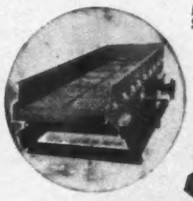

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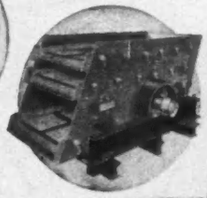

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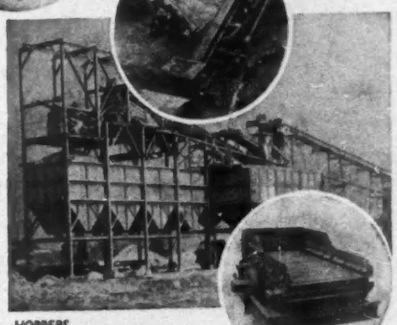

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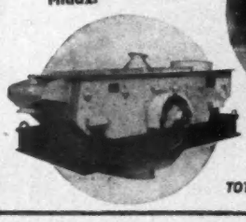

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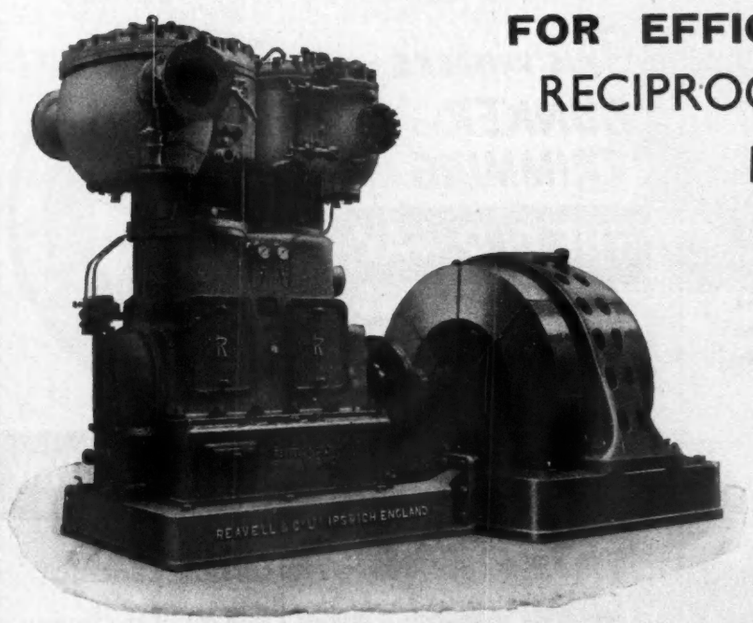

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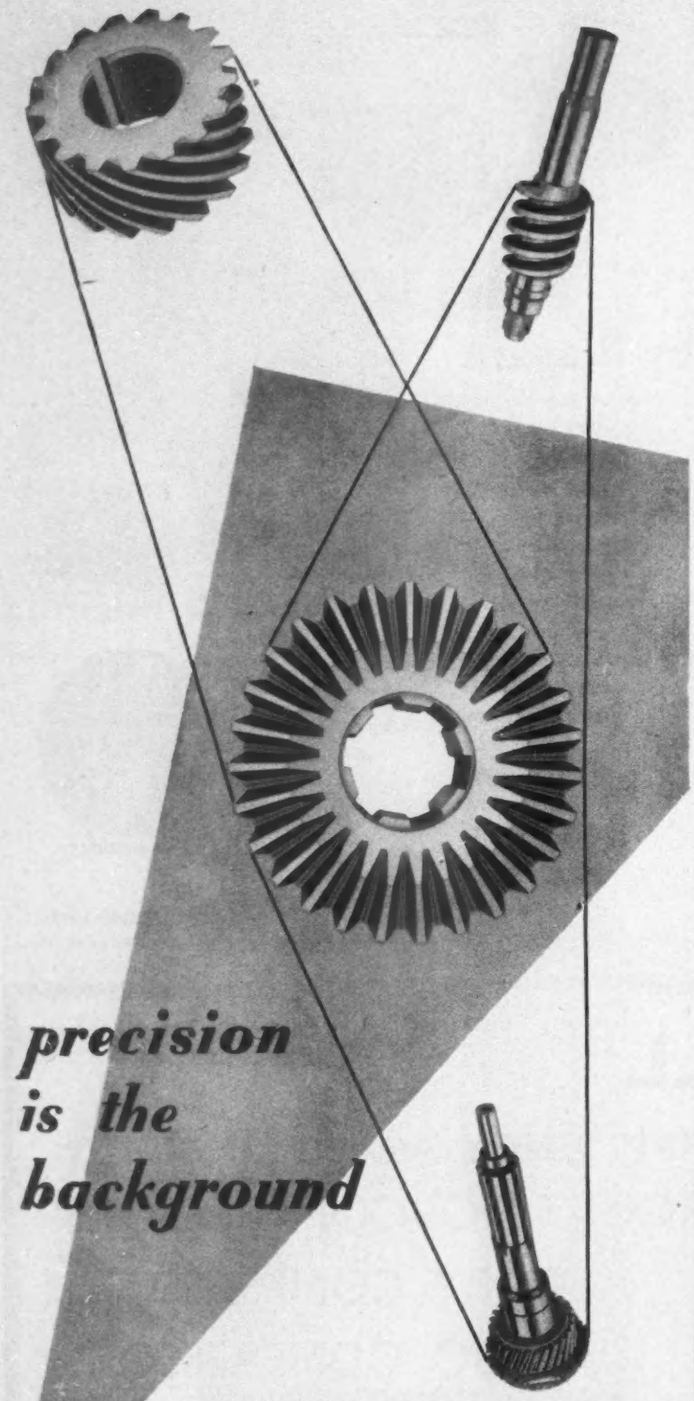

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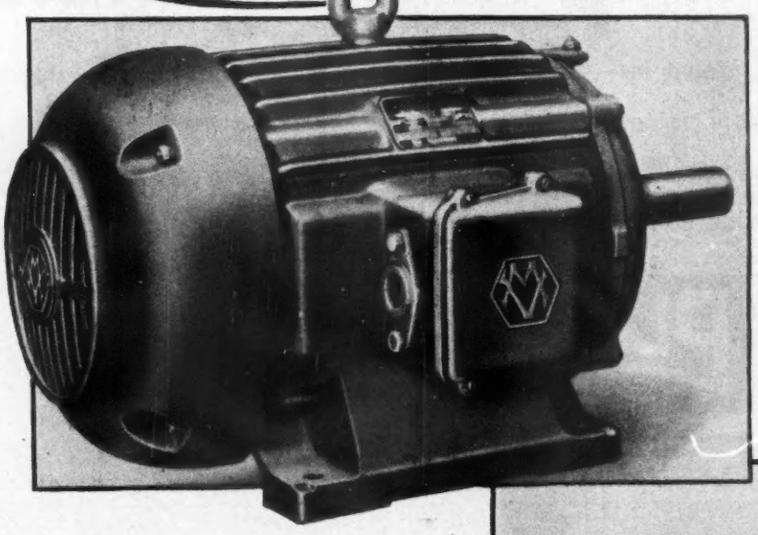

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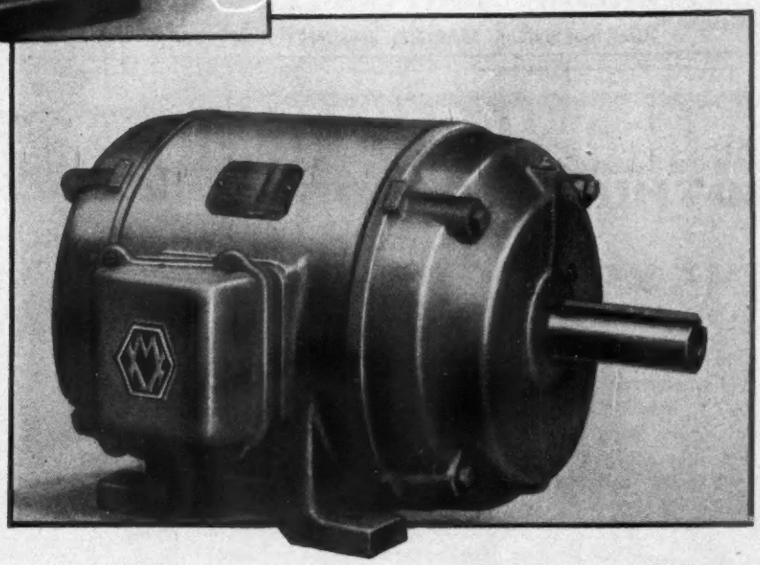

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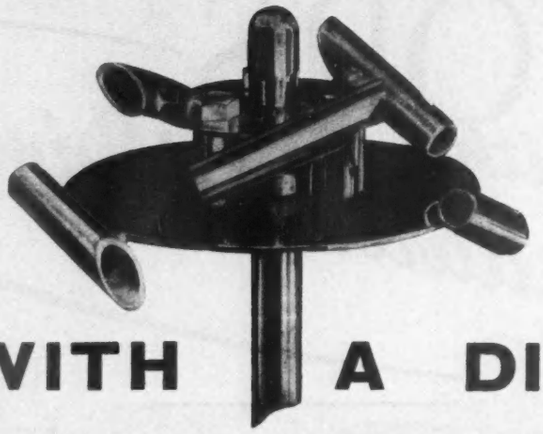

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Foundation requirements are reduced to a minimum (only two holding-down bolts to each unit).

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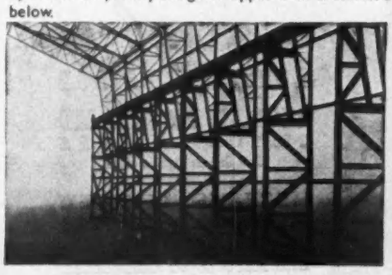
'KARISCOL' Buildings require no on-site riveting or welding, and can be erected by unskilled labour.

●SIZE
30ft. and 40ft. clear span.
(12ft. or 15ft. to eaves)
50ft. and 60ft. clear span.
(15ft. or 20ft. to eaves)
75ft. and 100ft. clear span.
(17ft. 6in. or 20ft. to eaves)
Extendible to any length in increments of 12ft. 6in. in single or multiple bays.

'KARISCOL' and CRANES

KARISCOL buildings can be supplied with gantries for electric or hand-operated cranes up to 5 tons, by means of specially designed supports as illustrated below.



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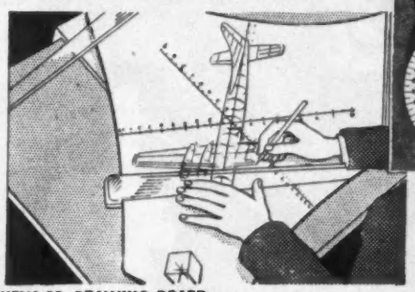

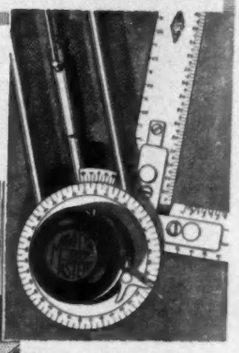

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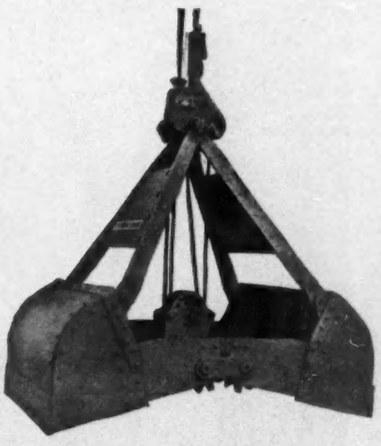

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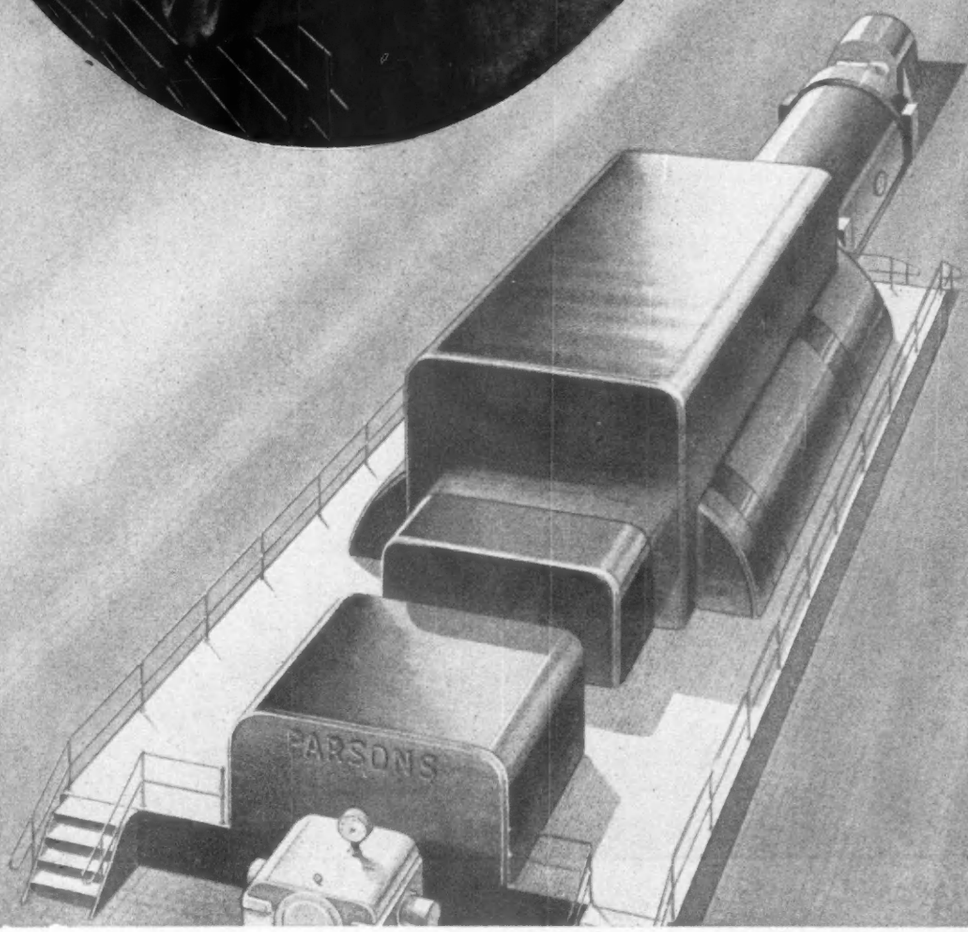

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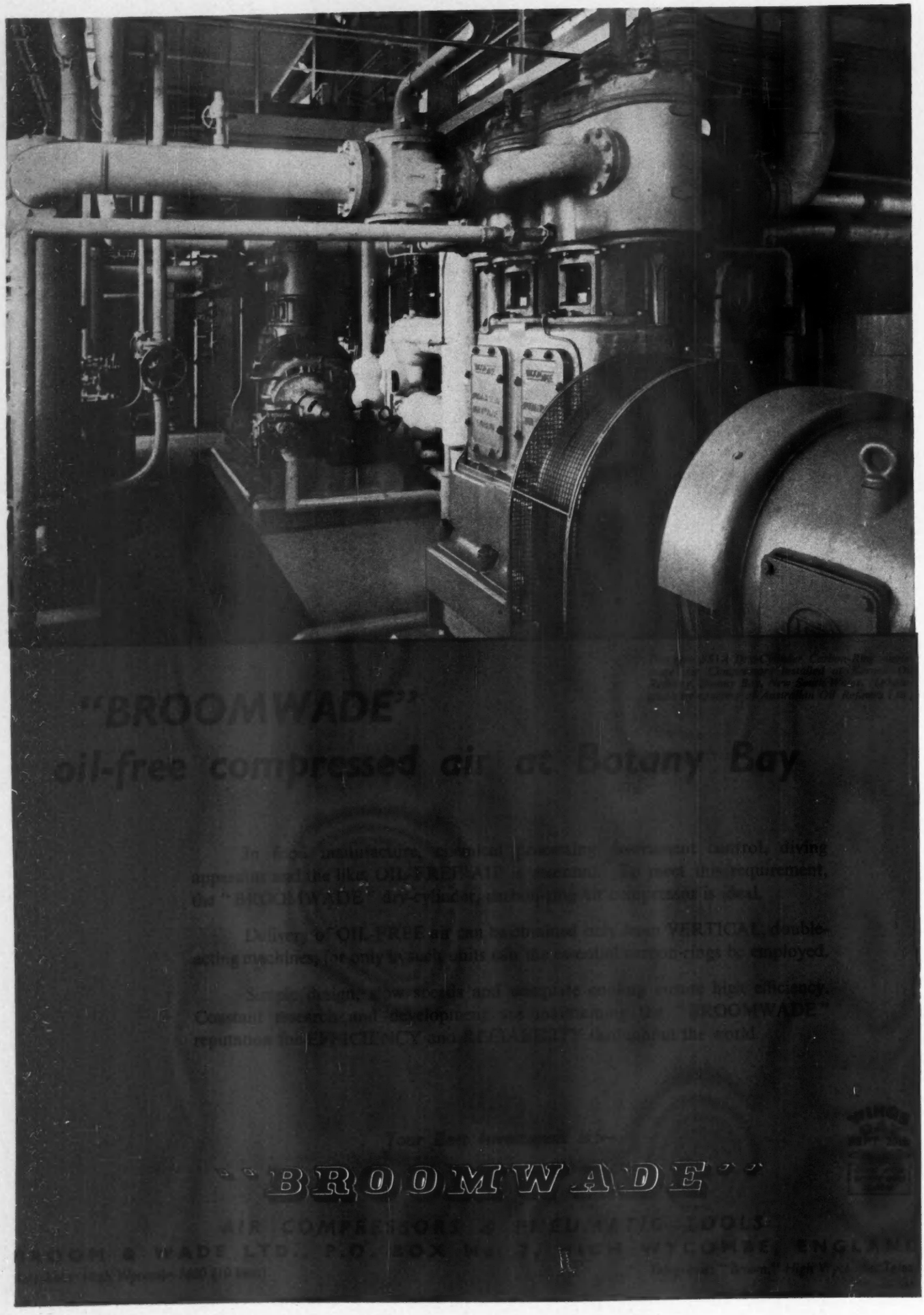
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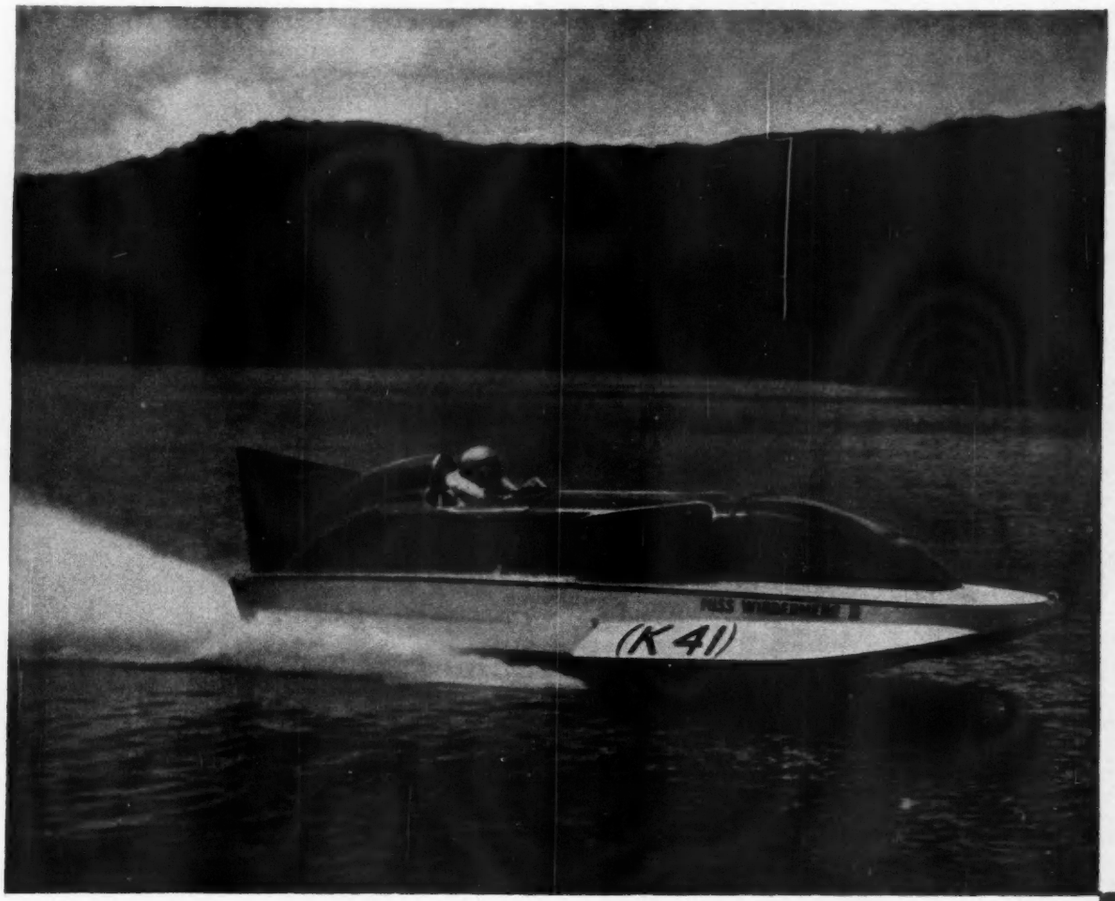

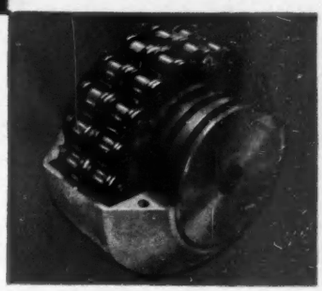

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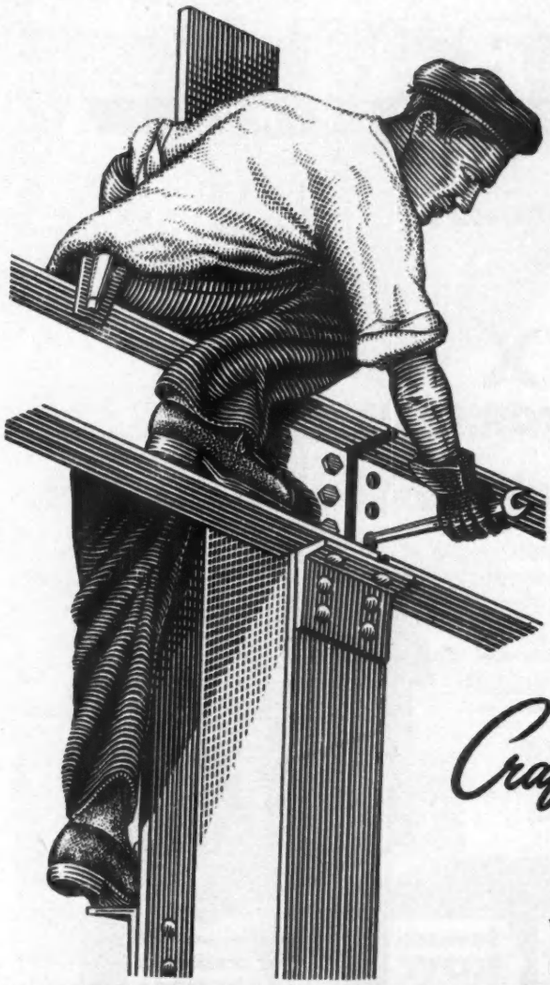

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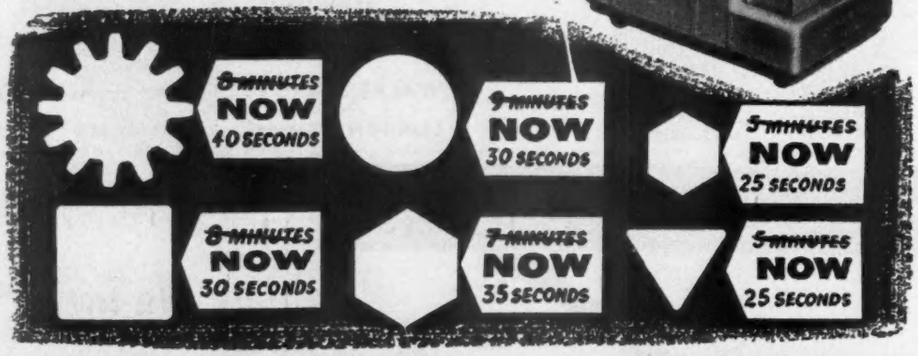
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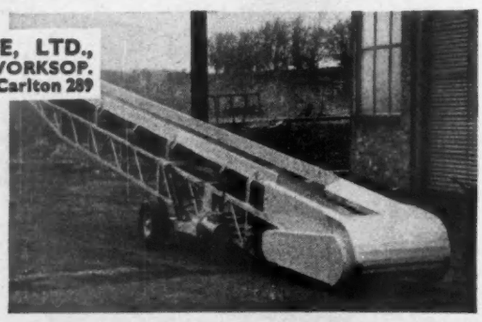

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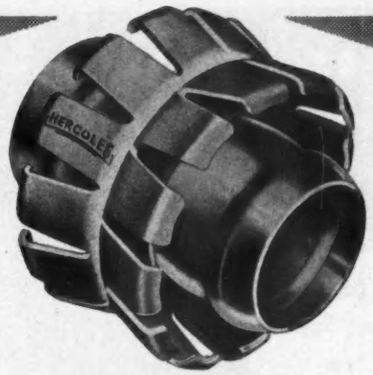

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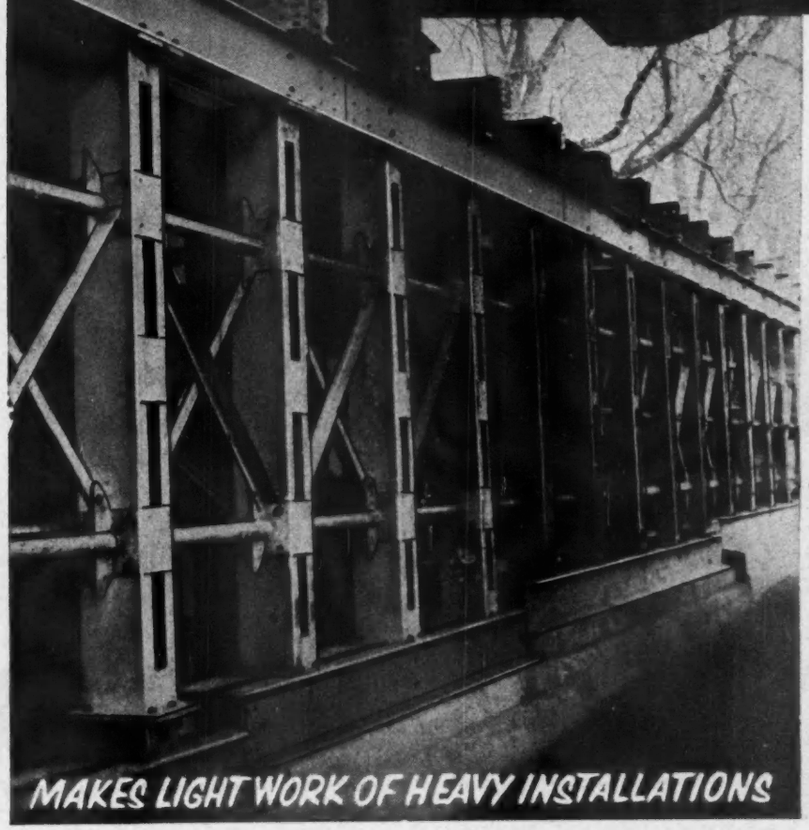

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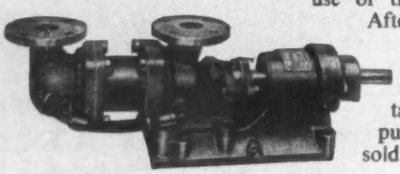

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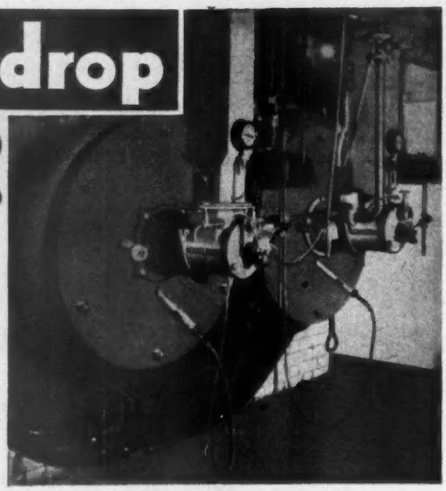

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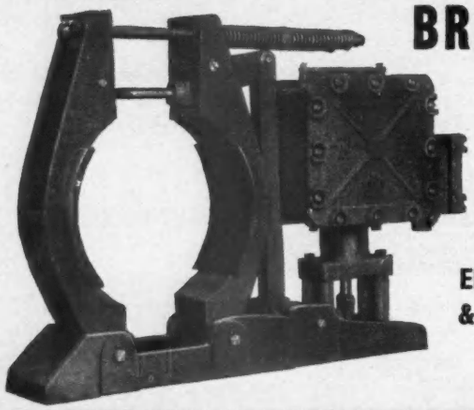

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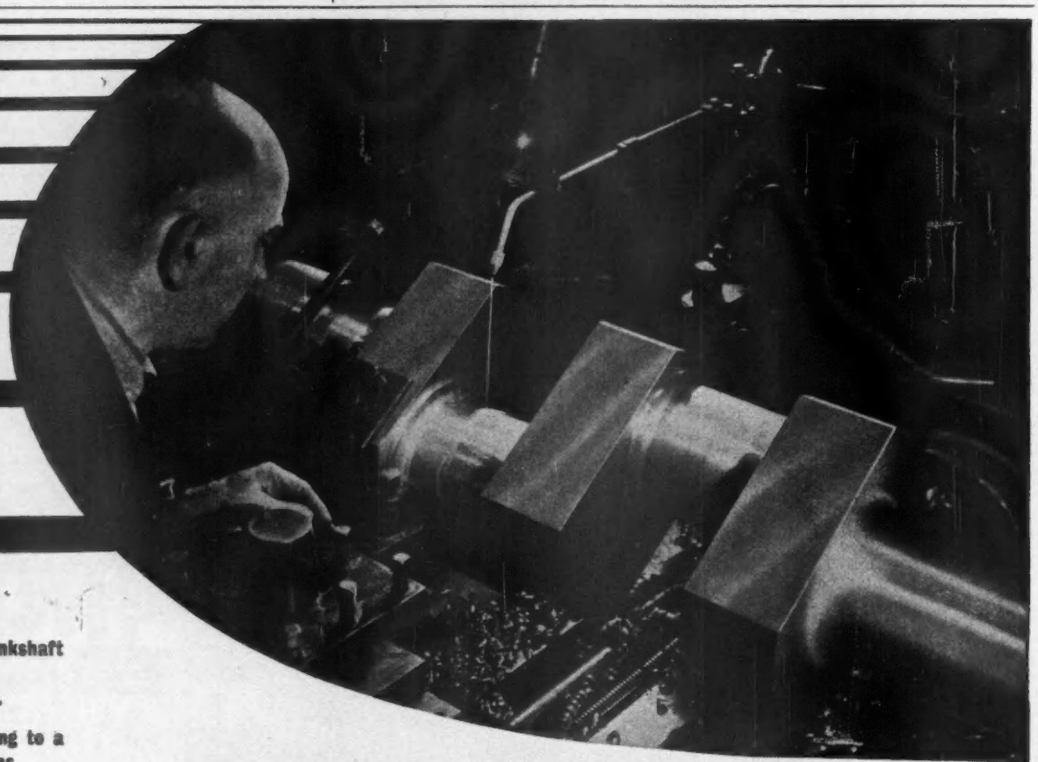

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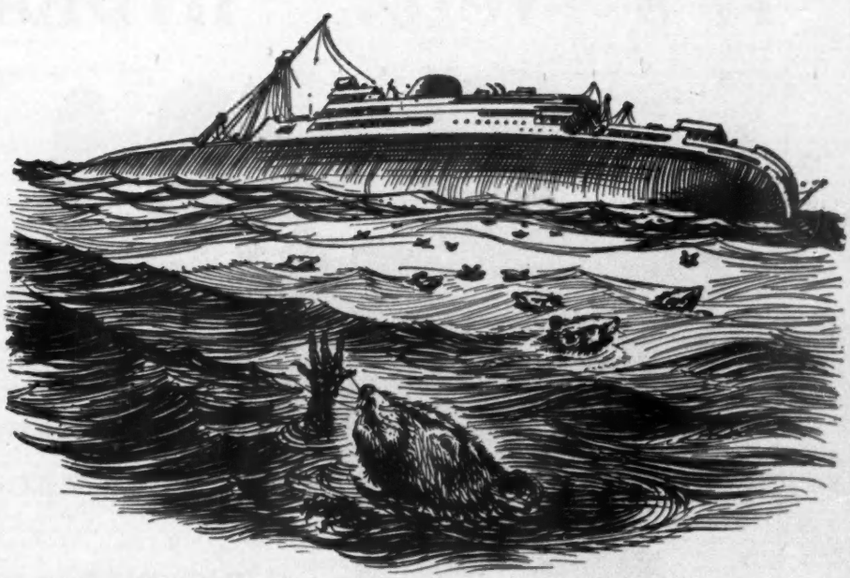

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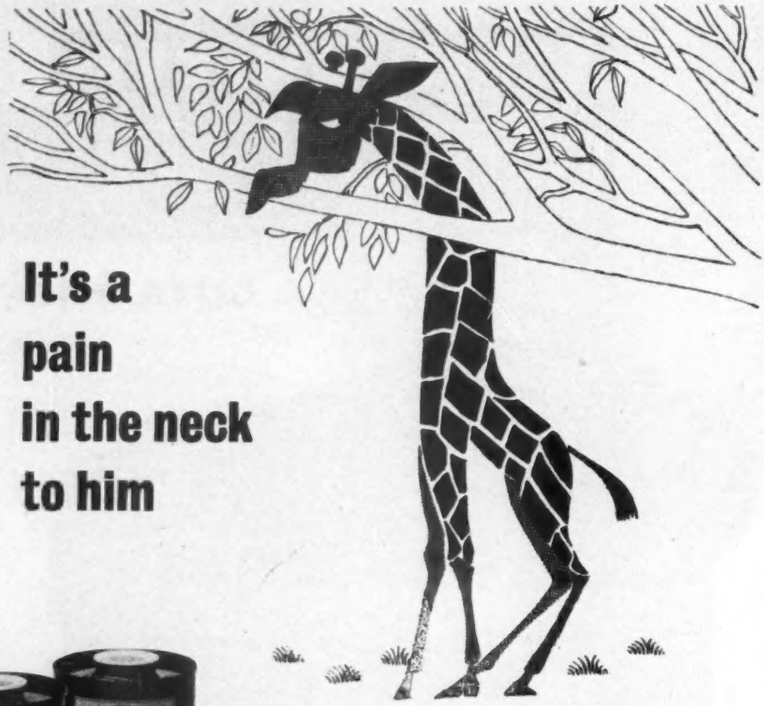

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Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch.
There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch.
There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-on and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

KUMASI COLLEGE OF TECHNOLOGY

Principal: W. E. DUNCANSON, Ph.D., D.Sc., F.Inst.P., A.M.I.E.E.

LECTURERS

Applications are invited for the following appointments :—

(a) SENIOR LECTURER or LECTURER IN ELECTRIC POWER MACHINES.
(b) SENIOR LECTURER and LECTURER IN ELECTRICAL ENGINEERING.

The College prepares students for the London University B.Sc. Degree in Engineering and for the examinations of the professional Engineering Institutions.

Qualifications: Good Honours Degree; A.M.I.E.E., or equivalent professional qualification; industrial and teaching experience in the case of those applying for the Senior Lectureships.

Appointment may be accepted on contract for 5 years or on pension. Arrangements to continue policies initiated under F.S.S.U. Scheme might be made by the College.

Contract Salary Scales: Senior Lecturer: £2125 by £75 to £2425 per annum; Lecturer: £1281 5s. by £62 10s. to £2031 5s. per annum; plus gratuity payable at end of contract at the rate of £12 10s. for each month of satisfactory service. Pensionable and F.S.S.U. Salary Scales: Senior Lecturer: £1580 by £60 to £1940 per annum; Lecturer: £925 by £50 to £1625 per annum. Point of entry according to experience.

Children's allowances up to a maximum of three at the rate of £50 per annum per child up to 10 years, and £100 per annum per child over 10 years in full-time education up to 21 years. Annual leave with free return first-class passages for member of staff and, conditional on minimum stay in West Africa, his wife and up to three children under 17 years. Bungalows with basic furniture at low rental provided. Income tax low.

Applications (6 copies), giving age, education, qualifications, experience and the names of 3 referees, should be sent to the Council for Overseas Colleges, 12, Lincoln's Inn Fields, London, W.C.2. Closing date 5th September, 1958. E8356

NORTH RIDING EDUCATION COMMITTEE

CLEVELAND TECHNICAL COLLEGE, REDCAR

ASSISTANTS

Applications are invited for the following posts for September, 1958, or as soon after as possible.
ENGINEERING DEPARTMENT

(1) ASSISTANT (Grade B) for ELECTRICAL ENGINEERING to O.N.C. level. Special responsibility allowance £100 per annum.
(2) ASSISTANT (Grade A) for MACHINE SHOP PRACTICE.
(3) ASSISTANT (Grade A) for AGRICULTURAL MACHINERY AND MOTOR VEHICLE SUBJECTS.
(4) ASSISTANT (Grade A) for SHEET METAL WORK AND WELDING.

Forms and particulars available from me on receipt of stamped, addressed envelope. Completed forms to be returned by 1st September, 1958.

F. BARRACLOUGH.
County Hall,
Northallerton. E8361

MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

APPOINTMENT OF DEMONSTRATOR IN MECHANICAL ENGINEERING DRAWING

Applications are invited for a DEMONSTRATORSHIP in the Department of Mechanical Engineering to assist in the Drawing-offices. Applicants should hold an appropriate degree, a Higher National Certificate in Mechanical Engineering or an equivalent qualification. Drawing-office experience is essential.

Salary in the scale £575 by £25 to £600. Superannuation under the F.S.S.U. Family Allowances.

Application forms may be obtained from The Registrar, The Manchester College of Science and Technology, to whom they should be returned not later than 13th September, 1958. E8350

PUBLIC APPOINTMENTS

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE,

BURTON STREET, NOTTINGHAM

Principal: D. A. R. CLARK, M.Sc. (Tech.), M.I.Mech.E.

ASSISTANT GRADE B IN MECHANICAL ENGINEERING

Applications are invited for the full-time appointment of ASSISTANT, Grade B, in MECHANICAL ENGINEERING.

A large new building comes into use in September next for well-equipped Departments of Building and Civil Engineering, Electrical Engineering, Chemistry, Physics and Mathematics, and Mining. Increased accommodation is also available to the Departments of Mechanical Engineering, Arts and Commerce, Printing and Textiles. Research work by both staff and students is being rapidly developed.

Experience in industry, teaching and/or research desirable.

Salary in accordance with the Burnham Technical Scale, as follows: £650 by £25 to £1025 per annum. Additions include Degree allowance of £75 per annum (or £125 for good Honours Degree), up to 3 increments of £25 for training in approved cases, and incremental allowance for industrial experience after age 21, and war service.

Further particulars and form of application may be obtained from the Principal, to whom completed forms should be returned not later than 5th September, 1958. E8342

KUMASI COLLEGE OF TECHNOLOGY

Principal: W. E. DUNCANSON, Ph.D., D.Sc., F.Inst.P., A.M.I.E.E.

SENIOR LECTURERS AND LECTURERS

Applications are invited for the posts of SENIOR LECTURERS and LECTURERS in the Department of Mechanical Engineering.

The College prepares students for the London University B.Sc. Degree in Engineering and for the examinations of the professional Engineering Institutions.

Applicants should have a Degree or equivalent qualifications, with suitable teaching and professional qualifications. Duties will involve some of the following: Teaching of Strength of Materials and Metallurgy, Theory and Design of Machines, Engineering Drawing; Taking Charge of Applied Thermodynamics Laboratory.

Appointment may be accepted on contract for 5 years or on pension or arrangements to continue policies initiated under the F.S.S.U. Scheme might be made by the College.

Contract Salary Scales: Senior Lecturer: £2125 by £75 to £2425 per annum; Lecturer: £1271 5s. by £62 10s. to £2031 5s., plus a gratuity payable at the end of contract at the rate of £12 10s. for each month of satisfactory service. Pensionable and F.S.S.U. salary scales: Senior Lecturer: £1580 by £60 to £1940; Lecturer: £925 by £50 to £1625. Point of entry according to experience.

Children's allowances up to a maximum of three at the rate of £50 per annum per child up to 10 years and £100 per annum per child over 10 years in full-time education up to 21 years. Annual leave with free return first-class passages for the member of staff and, conditional on a minimum stay in West Africa, for his wife and up to three children under 17 years. Bungalows with basic furniture at low rental are provided. Income tax low.

Applications (6 copies), giving age, qualifications, experience and the names of 3 referees, should be sent to the Council for Overseas Colleges, 12, Lincoln's Inn Fields, London, W.C.2. Closing date: 5th September, 1958. E8355

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

ISLEWORTH POLYTECHNIC

LABORATORY ASSISTANT

LABORATORY ASSISTANT (male) required at Isleworth Polytechnic, London Road, Isleworth. Duties include preparation and maintenance of apparatus mainly in Physics Laboratories. Salary Misc. II, £475–£535 if 26 years or over. Prescribed conditions.—Application forms from Principal, returnable immediately (Quote Y.39E.) Canvassing disqualifies. E8303

PUBLIC APPOINTMENTS

MIDDLESEX COUNTY COUNCIL

EDUCATION COMMITTEE

SOUTHALL TECHNICAL COLLEGE
BEACONSFIELD ROAD,
SOUTHALL, MIDDLESEX

HEADSHIP OF THE DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the HEADSHIP OF THE DEPARTMENT OF MECHANICAL ENGINEERING (Grade V), vacant from 1st January, 1959. Applicants should have a Degree in Mechanical Engineering, with professional qualifications and suitable industrial and/or research experience. Teaching experience at high level in a technical college is desirable and proved organising ability an additional recommendation. The appointment affords an excellent opportunity for the development of Sandwich Courses, Post-Graduate Technological Courses and research.

Salary in accordance with the Burnham Technical Report, 1956, i.e. £1900 by £50 to £2050 per annum, plus London allowance.

Forms (stamped, addressed, foolscap envelope) from the Chief Education Officer, F2, 10, Great George Street, Westminster, S.W.1. Closing date September 10th, 1958.

C. E. GURR, M.Sc., Ph.D.,
Secretary to the Education Committee.
E8307

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Royal Naval Scientific Service requires SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS for Establishments in London area, Baldock, Portsmouth, Portland, Poole, Greenock and Rosyth. Main requirements are about 25 vacancies for PHYSICISTS, ELECTRONIC ENGINEERS and MATHEMATICIANS in areas specified. The following particular vacancies also exist: MECHANICAL ENGINEER for work on gas turbine problems in the London area. MECHANICAL ENGINEER for work on design and development of U/W devices in Portland area. METALLURGISTS for Rosyth and Poole. CHEMISTS (Physical and Inorganic) for Poole area, Baldock and London. Candidates must normally be natural born British subjects of natural born British parents, with at least First or Second Class Honours degrees or equivalent high professional attainments. S.S.O.s must have had at least three years' post-graduate experience and be not less than 26 years of age. Salaries (men) S.S.O. £1190–£1410; S.O. £635–£1110 (London)—somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between the ages of 21 and 32 to compete for established posts.—Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A98/8A. E8092

LIVERPOOL REGIONAL HOSPITAL BOARD

ASSISTANT ENGINEER

ASSISTANT ENGINEER (MECHANICAL) required on the staff of the Regional Engineer.

Applicants should have passed the Institution examination and be Graduate Members of the Institution of Mechanical Engineers or Corporate Members of the Institution of Heating and Ventilating Engineers, and should preferably have had experience in the design, drawing up of plans and specifications for engineering equipment for hospitals, particularly heating, domestic hot water and ventilating schemes, be able to prepare complete working drawings from rough sketches and take the necessary particulars on site for complete engineering schemes. The successful applicant will take charge of the drawing-office.

Salary scale: £700–£1015 per annum.

Starting salary dependent on age and previous relevant practical experience.

Applications, stating age, qualifications, experience, present and previous posts, with names and addresses of three referees (2 technical), to reach me at 55, Castle Street, Liverpool, 2, by 8th September, 1958.

VINCENT COLLINGE,
E8337 Secretary to the Board.

PUBLIC APPOINTMENTS

MINISTRY OF SUPPLY RESEARCH AND DEVELOPMENT ESTABLISHMENTS

SCIENTIFIC OFFICERS

Ministry of Supply Research and Development Establishments, mainly in southern half of England, require: (a) SENIOR SCIENTIFIC OFFICERS (minimum age 26) and (b) SCIENTIFIC OFFICERS, for work in Physics, Electronics, Electrical or Mechanical Engineering, Applied Mathematics, Aerodynamics, Chemistry or Metallurgy. 1st or 2nd Class Hons. Degree or equivalent required and for S.S.O. at least 3 years' post-graduate experience.

Starting salary in range: (a) £1130–£1330; (b) £595–£1050 (male, in provinces). Rates for women reaching equality in 1961. Superannuation under F.S.S.U. Opportunity for those under 32 to compete for established posts. Candidates should indicate fields of work in which interested.

At National Gas Turbine Establishment, Pyestock, Hants., houses available for letting to married staff, and opportunities for new graduates to have workshop training.

Forms from M.L.N.S. Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.300/8A). E8328

EAST RIDING OF YORKSHIRE COUNTY COUNCIL

ENGINEERING ASSISTANT (HEATING)

Applications are invited for the permanent appointment of an ENGINEERING ASSISTANT (HEATING) on the staff of the County Architect at a salary in accordance with the N.J.C. Scales, A.P.T. I (£575–£725).

Candidates should preferably be Graduate Members of the Institution of Heating and Ventilating Engineers or the Institution of Mechanical Engineers, and should have had practical training and experience in the design, supervision and maintenance of heating and hot water installations.

Applications, giving particulars of age, training, qualifications, experience, past and present appointments, with salaries, together with the names of three referees, should be sent to the County Architect, County Hall, Beverley, not later than Friday, 5th September, 1958.

THOMAS STEPHENSON,
E8315 Clerk of the Council.

GOOD HOPE HOSPITAL,

SUTTON COLDFIELD

SENIOR ENGINEER

SENIOR ENGINEER required, to be stationed at this newly opened Hospital, and also to maintain services of two smaller Hospitals in the area. Applicants should have completed training in Mechanical Engineering and have a sound knowledge of the principles and practice of Institutional Boiler Plant, Engineering and Electrical Services generally. Preference will be given to candidates with an Ordinary National Certificate or the equivalent.

Salary: £615 by £20 (1) by £25 (3) by £30 (1) to £740 per annum for candidates qualified in accordance with P.T.B. Circular 51. The successful applicant will be required to live within the area. No housing accommodation is available.

Applications, stating age, present position, qualifications and experience, together with two names for reference, to be sent within seven days of appearance of advertisement to the Group Secretary, Lichfield H.M.C., 15, Trent Valley Road, Lichfield. E8343

CITY GENERAL HOSPITAL AND FIR VALE INFIRMARY,

SHEFFIELD, 5

SENIOR ENGINEER

Applications are invited from suitably qualified persons with a sound knowledge of hospital engineering procedures, for the post of SENIOR ENGINEER at the above hospitals.

Salary on scale £740 by £25 (2) by £30 (3) to £880 per annum-(30½ points and over). A house is available on rental.

Applications should be submitted on the official application form, which is available from the Group Secretary, Nether Edge Hospital, Sheffield, 11. E8341

Classified Advts. continued on page 104

PUBLIC APPOINTMENTS

STATE ELECTRICITY COMMISSION OF VICTORIA

AUSTRALIA

BRIQUETTE PRODUCTION STAFF

The State Electricity Commission of Victoria, Australia, seeks application from engineers with the required qualifications and experience for appointment to senior positions at its new Briquette Production Works at Morwell, in the Latrobe Valley, in Eastern Victoria, approximately 90 miles from Melbourne.

The Commission, constituted as a semi-government authority by Act of Parliament, is one of the largest electricity supply authorities in the Commonwealth of Australia and the largest producer of fuel, with brown coal and briquette enterprises in the Latrobe Valley. It has a capital investment of approximately £A250-million, with an annual revenue of £A36 million.

The briquette works at present operated by the Commission are situated at Yallourn, approximately six miles from Morwell, where over 600,000 tons of brown coal briquettes are produced each year. To satisfy the State's ever-increasing demand, the Commission is now developing, at Morwell, its second brown coal power and fuel project. This will comprise a major brown coal open cut and a large new power station, which will operate in association with large modern briquetting works. The new briquetting works will supply briquette fuel for power stations in Melbourne and provincial cities and a large proportion of Victoria's solid fuel requirements for industrial and domestic use. The Morwell Project is due to begin generating electricity and producing briquettes during 1959, and it is expected that, by 1961, the production of briquettes will be at the rate of 1,500,000 tons a year.

Facilities in this rapidly developing area include excellent schooling, shopping and sporting facilities, subsidised medical and hospital services, and the other modern amenities of urban areas.

The positions for which applications are invited are as follows :—

BRIQUETTE PRODUCTION SUPERINTENDENT
Salary up to £A2665 per annum.

Applicants, preferably, should possess a University Degree or Higher National Certificate in Mechanical Engineering or be Chartered Engineers, or possess equivalent qualification, and must have had extensive practical experience in the operation and maintenance of heavy industrial processing plant. Administrative ability in production control and the direction of personnel is essential.

Consideration will be given to applicants who possess a First Class M.O.T. or B.O.T. Certificate of Competency, provided details of practical experience are satisfactory.

A knowledge of the details of the brown coal briquetting process is desirable.

The appointee will be responsible for all the administrative aspects concerned with the production of briquettes and the direction of all personnel engaged in the operation and maintenance of plant and equipment at the Morwell Briquette Works.

ASSISTANT BRIQUETTE PRODUCTION SUPERINTENDENT
Salary up to £A2465 per annum.

Applicants, preferably, should possess a University Degree or Higher National Certificate in Mechanical Engineering, or be Chartered Engineers, or possess equivalent qualification, and must have had extensive practical experience in the operation and maintenance of heavy industrial processing plant. Administrative ability in production control and the direction of personnel is essential.

Consideration will be given to applicants who possess a First Class M.O.T. or B.O.T. Certificate of Competency, provided details of practical experience are satisfactory.

A knowledge of the details of the brown coal briquetting process is desirable.

The appointee will be responsible, under the direction of the Briquette Production Superintendent, for the efficient operation and maintenance of all plant and equipment at the Briquette Works and for the effective disposition of personnel.

FACTORY OPERATIONS SUPERINTENDENT
Salary up to £A2265 per annum.

Applicants should possess a Higher National Certificate in Mechanical Engineering, or be Chartered Engineers, or possess a First Class M.O.T. or B.O.T. Certificate of Competency, and must have had extensive practical experience in the operation of heavy industrial processing plant. Ability to efficiently direct and control personnel is essential.

A knowledge of the details of the brown coal briquetting process and of rosters is desirable.

The appointee will be responsible, under the Assistant Briquette Production Superintendent, for the efficient operation of all mechanical production plant and will be required to supervise personnel engaged on operational duties. He will be responsible for the training and administration of the works fire-fighting services and may be required to be available for after-hours duty.

The cost of passages to Australia for appointees and their families will be borne by the State Electricity Commission and arranged by the Agent-General for Victoria, London.

Suitable houses for rental will be made available immediately to married appointees, and good hostel accommodation at a reasonable tariff will be available for single appointees.

Married appointees will be reimbursed, at the expiration of six months' satisfactory service, an amount of up to £A150 upon production of necessary receipts, in respect of removal of household furniture and effects.

Further details may be obtained on application to the Staff Superintendent at the address mentioned below.

Applications, giving full details of qualifications, experience and war service (if any), stating date of birth and accompanied by copies of testimonials, should be submitted, not later than 10th October, 1958, to the Secretary, State Electricity Commission of Victoria, 22–32, William Street, Melbourne, C.1, Victoria, Australia. E8333

PUBLIC APPOINTMENTS

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

HYDRAULICS RESEARCH STATION, WALLINGFORD

SENIOR SCIENTIFIC OFFICER OR SCIENTIFIC OFFICER

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER required at Hydraulics Research Station, Wallingford, in team working on problems connected with movement of sand and silt, and erosion of coherent materials in steady and tidal flow. Qualifications : First or Second Honours Degree in Aerodynamics, Physics, Mechanical or Civil Engineering, with some research experience in fluid mechanics. Experience in turbulence studies an advantage. Salary ranges (men) : S.O., £595 to £1050 ; S.S.O. (minimum of three years' post-graduate experience), £1130 to £1330.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.298/8A). Closing date 5th September, 1958. E8310

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT

ALDERMASTON, BERKSHIRE

ENGINEERS

The Atomic Weapons Research establishment, Aldermaston, Berkshire, requires ENGINEERS, to work as members of a team engaged upon the design and development of mechanical and electro-mechanical equipment of unique and unorthodox design. There will be one post for a specialist in vibration measurement techniques.

A recognised engineering apprenticeship and A.M.I.Mech.E. or A.M.I.E.E. or equivalent qualifications are required with considerable experience in the design of mechanical, electro-mechanical and/or electronic equipment.

Salary : £1300–£1740.

Contributory superannuation scheme. A house or assistance towards legal expenses on house purchase will be available for married officers living beyond daily travelling distance.

Postcards for application forms to the Senior Recruitment Officer at above address. Please quote ref. 1982/25. E8304

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

MECHANICAL ENGINEERING RESEARCH LABORATORY, EAST KILBRIDE, GLASGOW

PRINCIPAL SCIENTIFIC OFFICER

Pensionable post for ENGINEER or PHYSICIST at least 31 on January 1st, 1958, at Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead team carrying out research on heat transfer in a new laboratory with exceptional facilities. Qualifications normally First or Second Class Honours Degree in an appropriate subject or high professional attainment. Sound knowledge of basic principles and experimental techniques of heat transfer and fluid mechanics necessary. Industrial experience desirable. Salary scale (men), £1370–£1950. Good housing prospects.—Write Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, for application form, quoting No. S 4881/58. Closing date 23rd September, 1958. E8311

WEST GLOUCESTERSHIRE WATER COMPANY

APPOINTMENT OF AN ASSISTANT ENGINEER

Applications are invited from suitably qualified engineers for the post of an ASSISTANT ENGINEER at a salary of £1025 to £1175 per annum (A.P.T. Grade IV). Candidates must have sound waterworks experience.

The company have a pension scheme and can also arrange for continuance of membership in the Local Government Superannuation Scheme. A car allowance is available.

Intending candidates should write to the undersigned for further particulars and should submit their applications, accompanied by three recent testimonials, not later than 11th September, 1958.

W. G. CLOSE, A.M.I.C.E., A.M.I.W.E.,
General Manager and Engineer.
Kingswood,
Bristol. E8335

PUBLIC APPOINTMENTS

EAST MIDLANDS GAS BOARD

LINCOLNSHIRE DIVISION

DIVISIONAL ENGINEERING ASSISTANT

Applications are invited from suitably qualified candidates for the above appointment at Divisional Headquarters, Lincoln.

Applicants should have served a recognised apprenticeship in the gas industry, and have had experience of the layout and installation of new plant. Site experience in the constructional field would be desirable.

A degree in engineering (Civil, Mechanical or Electrical) and/or corporate membership of one of the Engineering Institutions would be an advantage.

The salary for the post will be within Grades APT.10/12 of the National Salary Scales for Gas Staffs (£860 to £1070). The initial placing will be dependent upon the qualifications and experience of the successful candidate.

The post is pensionable and the successful applicant will be required to pass a medical examination.

Applications giving details of age, education, qualifications and training, together with the names and addresses of two referees should be addressed to reach the undersigned not later than the 8th September, 1958.

BERNARD CLARKE,
Divisional General Manager.
Belle Vue House,
Carline Road,
Lincoln. E8352

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

INDUSTRIAL GROUP HEADQUARTERS

ENGINEERING ECONOMICS

The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, requires an ENGINEER in the Commercial Department of its Industrial Power Branch at Risley, Warrington, Lancashire, to handle calculations relating to the economics of nuclear energy.

Applicants must be Corporate Members of a Senior Engineering Institution, or possess equivalent qualifications, and be thoroughly familiar with the financial aspects of the operation of conventional power stations. Qualifications in Statistics or Economics would be an advantage.

Salary will be assessed within the scale £815 (at age 25) to £1270.

Contributory pension scheme.

A house or assistance towards legal expenses on house purchase may be available.

Send postcard for application form, quoting reference 2555, to Recruitment Officer, Industrial Group Headquarters, Risley, Warrington, Lancashire.

Closing date : 8th September, 1958. E8306

ESSEX RIVER BOARD

TWO CIVIL ENGINEERING ASSISTANTS

Applications are invited for the following permanent posts, which are subject to the Local Government Superannuation Acts, 1937 and 1953.

TWO CIVIL ENGINEERING ASSISTANTS, A.P.T. III (£845–£1025).

Applicants should be Chartered Civil Engineers experienced in coast protection works and/or the design and calculation of river improvement schemes or surface-water sewerage schemes. Experience in the design of pumping stations would be an advantage.

Car allowance on the Essential Users' scale will be payable.

Applications, giving details of age, education and previous experience, and the names of three referees with a knowledge of the applicants' technical experience, should be submitted to the Engineer to the Board at the address given below, not later than the 20th September, 1958.

(signed) W. J. S. BEW,
Clerk of the Board.
Rivers House,
129, Springfield Road,
Chelmsford, Essex.
12th August, 1958. E8316

PUBLIC APPOINTMENTS

MERSEY DOCKS AND HARBOUR BOARD

RESIDENT ENGINEERS AND ENGINEERING ASSISTANTS

Applications are invited for the positions of :

(a) RESIDENT ENGINEERS (2)—each to be responsible to the Engineer-in-Chief for the supervision and day-to-day running of all the dock works (which may include new construction and reconstruction) within one of the four Districts into which the Estate is divided.

(b) ENGINEERING ASSISTANTS—TEMPORARY (2)—for work on site of a major Docks reconstruction scheme now in progress in Liverpool.

Candidates should be Corporate Members of the Institution of Civil Engineers although Graduate Members of the Institution would be considered for (b).

The Salary for Appointment (a) will be £1300 per annum and for (b)—duration 2/3 years—up to £1100 per annum according to qualifications and experience.

Applications stating age, qualifications and experience should be addressed to the Engineer-in-Chief, Dock Office, Liverpool, 3. Closing date September 2, 1958.

A. S. MOUNTFIELD,
General Manager and Secretary.
Dock Office,
Liverpool, 3. E8347

BIRMINGHAM REGIONAL HOSPITAL BOARD

APPOINTMENT OF REGIONAL ENGINEER

Wide experience essential in design and operation of engineering plant, especially of heating, hot water and ventilating systems, preferably in hospitals or large undertakings. Essential qualifications : Corporate Membership of Institutions of Civil, Mechanical or Electrical Engineers or appropriate engineering appointment of professional grade in hospital service. REGIONAL ENGINEER will be wholetime officer responsible to Board for efficient working of his department ; salary £1885 by £80 (1) by £85 (4) by £50 (1) to £2355. Further particulars from Secretary, Regional Hospital Board, 10, Augustus Road, Birmingham, 15. Applications naming three referees to be received by 1st September, 1958. Interviews mid-September. E8103

COUNTY BOROUGH OF BOLTON

WATERWORKS DEPARTMENT

ENGINEERING ASSISTANT

Applications invited for appointment of ENGINEERING ASSISTANT, Grade A.P.T. IV (£1025–£1175). Candidates must be Chartered Engineers (Civil or Mechanical) and have experience in the design, construction or operation of waterworks plant or structures. The appointment is superannuable subject to medical examination.

Applications giving details of age, training, qualifications and experience and naming three referees, must be received by me not later than 3rd September.

PHILIP S. RENNISON,
Town Clerk.
E8348

CIVIL SERVICE COMMISSION

CIVIL ENGINEERS

Pensionable posts for men and women aged 25 and under 35 on 1st January, 1958 ; extension for regular Forces service, H.M. Overseas Civil Service, Established Civil Service and temporary Government Service as Civil Engineer. Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining Corporate Membership.

Men's starting salary from £755 to £1085. Maximum (London) £1250. Promotion prospects.

Write, Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting S64/58. E8357

A.E.R.E. HARWELL

DESIGN AND PRODUCTION

PROFESSIONAL ENGINEERS (DESIGN) are required, one to lead and one to assist him with a team of engineers giving a project service to Research Divisions. The duties include liaison with scientists, preparation of design specifications and layouts and technical supervision through all stages from basic design to commissioning.

Design experience in one or more of the following is essential: high vacuum equipment ; chemical plant ; high temperature furnaces ; mechanical handling equipment ; other plant and apparatus for research. For the senior post significant experience in this work in a responsible position is required.

Salary : £1790—£2080 (Engineer I)
£1300—£1740 (Engineer II).

Send POSTCARD for application form and details to the Group Recruitment Officer (1185/25), *U.K.A.E.A., Atomic Energy Research Establishment, Didcot, Berks.*

E8324

TENDERS

COUNTY OF NORTHUMBERLAND

SUPPLY OF NEW HIGHWAY PLANT

The above Council invite TENDERS for the SUPPLY of the following items of NEW HIGHWAY PLANT :—

3 (No.) 110 cubic feet Air Compressors.
2 (No.) 3 roll 8/10 ton Diesel Rollers.
2 (No.) Diesel-Mechanical Sweeper Collectors.
2 (No.) 3/4-ton Diesel Motor Wagons.
3 (No.) 5/6-ton Diesel Motor Wagons.

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E. P. HARVEY,
Clerk of the County Council.
E8323

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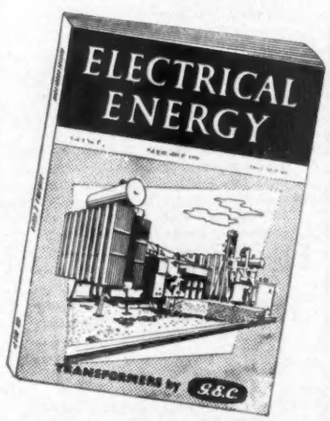

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The Director General of India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

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Forms of Tender may be obtained from the above address on or after the 22nd August, 1958, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on Monday, 29th September, 1958.
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E8339

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29, WRIGHT'S LANE, LONDON, W.8.
E102

NOTICE

UNIVERSITY OF MANCHESTER

The next SESSION COMMENCES on THURSDAY, 2nd OCTOBER, 1958.

E8251

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A FIRM OF INTERNATIONAL REPUTE HAS VACANCIES for qualified ENGINEERS aged 30/35, preferably with experience with high pressure gases. Successful applicants would receive specialised training and would be responsible for development in various industrial areas in this country. A salary in the region of four figures will be offered. Reply, giving details of age, qualifications and experience.—BOX No. E8354, "The Engineer." A

A WELL-KNOWN GENERAL ENGINEERING COMPANY in the North West of Lancashire has a vacancy for a qualified RATEFIXER AND TIMESTUDY ENGINEER. Applicants must have served an engineering apprenticeship and have had considerable experience in this type of work.—Please supply full details of age, experience, salary required, etc., to BOX No. E8336, "The Engineer." A

ASSISTANTS with knowledge of contractors plant, solid fuel stocking or electrical wiring or temperature recording, required to be mobile for United Kingdom or Continental contracts, good salary, bonus and career for dedicated or boffin types. Also young Lady ASSISTANT SECRETARY for interesting work, some travelling, able to take shorthand whilst motoring, and having good memory.—Write history from birth to Penfold and Partners, Consulting Engineers, 120/122, Victoria Street, London, S.W.1. E2063 A

ASSISTANT DEVELOPMENT ENGINEER REQUIRED. Experienced in small electro-mechanical, hydraulic and pneumatic devices. H.N.C. standard.—Apply Manager, Instrumentation Division, Evershed and Vignoles, Ltd., Acton Lane Works, Chiswick, W.4. E2064 A

AN EXECUTIVE ENGINEER

is required by one of the country's major companies engaged in the Design, Procurement and Construction of Chemical and Oil Refinery Plants.

The Company is looking for a fully qualified man who has successfully managed multi-million projects in this field.

Applicants should already be in receipt of a minimum salary of £2500.

All enquiries will be treated in the strictest confidence and should be addressed to the Managing Director.—BOX No. E8266, "The Engineer."

BRITISH PETROLEUM COMPANY, LTD., has a vacancy for a MECHANICAL ENGINEER for service in KUWAIT. Applicants, aged 25–35, must hold Higher National Certificate and have served an apprenticeship in Mechanical or Automobile Engineering. Experience in the following advantageous :—(a) Mechanical driven pumps, (b) motor transport, (c) engineering drawing-office, (d) liquid meters, (e) aircraft refuelling, (f) marine engineering. Successful applicant will be required to supervise maintenance of existing autocars, P.T. unit and Cornwall fueller. He will also be responsible for the airfield depot and all fuelling operations, including refuelling by small hydrant system. Attractive salary, free passage out and home, free medical attention, kit allowance, pension scheme, good leave arrangements.—Write, giving full particulars, quoting F.560, to BOX 3111, c/o 191, Gresham House, E.C.2. E8313 A

CHIEF DESIGNER required for manufacturer of Commercial and Municipal Bodywork, Trailers and Semi-trailers. Midlands area. Apply, stating age, experience and salary required, in confidence, to the Managing Director.—BOX No. E2061, "The Engineer." A

CHIEF ENGINEER required for modern works in the Midlands, engaged in the production of light alloys in all wrought forms (sheet, strip, extrusions, wire, tube, pressings and forgings). The post is one demanding organising ability, in addition to the obvious requirement of a first-class training in mechanical and electrical engineering. The duties cover the complete charge of a large engineering department. This includes a drawing-office handling the design and specification of all machinery and plant and workshops dealing with the manufacture, erection, maintenance and repair of all plant, services and equipment. A knowledge of general heavy engineering is essential, preferably associated with rolling mills and hydraulics. The salary will be in accordance with training and experience, the position being a progressive one offering an excellent opportunity to a man between 35 and 45. Applicants should give chronological details of their training and experience, and state age and salary level expected.—BOX No. E8325, "The Engineer." A

CONSTRUCTIONAL ENGINEER required for supervision of installation of Capital plant in foundries. Practical experience of site supervision essential and some drawing office experience preferred. Age between 25 and 35. Car provided.—Apply in writing to Managing Director, Fuel and Metallurgical Processes, Ltd., Normanhurst Chambers, 21, St. James' Road, Dudley, Worcs. E2058 A

CONSULTING ENGINEERS engaged on varied R.C. and Steel Structural Works, general civil engineering work and foundation problems require capable Designer/Detailer. Five-day week and luncheon vouchers. Apply.—Maurice Nachshen and Partners, 58, Victoria Street, S.W.1. E8299 A

DESIGNER DRAUGHTSMAN required for Development Department of large industrial concern in the Midlands. This work will include a wide range of plant design, development of prototype machines, factory planning and layout, progressing installation programmes and study of machine operational efficiency. Good prospects of promotion—Applications are invited from persons holding at least H.N.C. in Mechanical Engineering or equivalent, stating qualifications, experience and present salary to Personnel Manager, BOX No. E8282, "The Engineer." A

DEVELOPMENT ENGINEER required by Shorrock Superchargers, Ltd., to be responsible to the Technical Director for oil burner development work and associated appliances. H.N.C. or equivalent and engineering apprenticeship desirable. Furnace and/or oil burner experience necessary and general development engineering experience. Age group suggested 25 to 35, but not essential. Ability to co-operate with other people very important. Salary in accordance with qualifications and abilities. Superannuation scheme. Shorrock Superchargers, Ltd., is a subsidiary of Rubery, Owen and Co., Ltd.—Send details of background and experience to Personnel Manager, Rubery, Owen and Co., Ltd., P.O. Box 10, Darlaston, Wednesbury, Staffs. E2062 A

DRAUGHTSMAN with two to three years' structural Steel Engineering experience required.—Apply in writing stating age, qualifications and salary required : Rapid Metal Developments, Ltd., 209, Walsall Road, Perry Bar, Birmingham, 22. E2055 A

DRAUGHTSMEN required by Mid-Tyne firm of marine engineers for work on engine room pipe arrangements, engine and boiler details. Write, giving details of experience.—BOX No. E8362, "The Engineer." A

ELECTRICAL ENGINEER required for work on design and development of precision servo motors and associated components. Previous experience in this field desirable. Higher National Certificate or equivalent qualifications essential. Salary according to age and experience.—Write, giving full details, to Naval Manager, Evershed and Vignoles, Ltd., Acton Lane Works, Chiswick, London, W.4. E2049 A

Classified Advts. continued on page 106

SITUATIONS VACANT

ENGINEER (MECHANICAL).—Applications are invited from Engineers, not over 35 years, who possess First Class M.O.T. Certificates (Steam). Willing to reside in or near London for duties in that area and to undertake three-monthly tours of inspections of boilers, pressure vessels, &c., in West Africa. Salary in accordance with age, previous experience, if any, plus expenses and allowances. Non-contributory pension scheme.—Apply in own handwriting to BOX No. E8227, "The Engineer." A

EXPERIMENTAL AND RESEARCH ENGINEERS

British Nylon Spinners continue to expand and invite applications from Corporate and Graduate Members of the Institution of Mechanical Engineers interested in Experimentation and Research.

The work covers a field including Machine Dynamics, Heat Transfer, Servo Control Systems, Electronic Circuit Design, Analogue Simulations and Stress Problems.

Each Engineer must be capable of undertaking a variety of such problems, for which, primarily, he will be solely responsible. He should have, therefore, high academic qualifications and a real feeling for this type of work. The works are most attractively situated, while conditions of employment are equivalent to the best obtainable. Likely applicants will be invited to meet the Engineering Staff in order to discuss the work.

Rented houses may be made available to married staff while assistance is given with removal expenses.

Please write, quoting Ref. 77, to the Personnel Manager, British Nylon Spinners, Pontypool, Monmouthshire. E8274 A

FOREMAN PIPE LAYER required to supervise direct labour teams engaged on the installation of water services on a large-scale engineering project in the North of England. Applicants should have extensive experience in laying steel and cast-iron pipes up to 36in. diameter with standard types of jo nts, although experience of welded joints is not essential. —Write, giving details of age, experience to date and salary required to: British Oxygen Wimpey, Ltd., M. and E. Department, Spadeadam Research Establishment, Gilsland, Near Carlisle. E8294 A

GEAR CALCULATOR with experience in all types of Spur and Bevel gears including spiral bevel and hypoid gears as produced to the Gleason system required for progressive medium-sized firm in N.W. London. Salary in accordance with qualifications and experience. Staff canteen. Pension scheme.—Please write in strict confidence to BOX A.791, c/o Streets, 110, Old Broad Street, E.C.2. E8351 A

H. J. HEINZ & CO., LTD., 57 VARIETIES require an INDUSTRIAL ENGINEER at their factory at Harlesden, London, N.W.10. This position has arisen owing to continued expansion and will be of interest to men of 25–35 who possess at least 3 years' experience in the field of Work Study and related techniques. The duties are largely concerned with materials handling and storage problems and the appointed candidate will be required to acquaint himself with the latest developments in the mechanical handling field, which can be related to our own needs. An ability to execute projects with a minimum of supervision and to compile reports clearly and concisely is essential. Applications are invited from Graduates, although men of high calibre, possessing outstanding experience will also be considered.—Please apply to Personnel Officer, giving full details of age, education and experience. E8340 A

HEATING INTERMEDIATE DRAUGHTSMAN required in London accustomed to design with minimum supervision. Salary up to £1000 per annum to right man. Permanent position with pension facilities and excellent prospects.—Write in confidence, stating full details of age, experience and past employers to Ellis (Kensington), Ltd., Kendrick Place, London, S.W.7. E2001 A

JACKSON BROS (OF KNOTTINGLEY) LTD.

have vacancy for an ENGINEER for maintenance and development work in modern glass-producing factory.

Candidates should have served an engineering apprenticeship, be Corporate Members of the Institution of Mechanical Engineers, or have H.N.C. in Mech. Eng. and be between 25 and 30.

Successful candidate will be one of a team responsible to Chief Engineer for maintenance of air compressors, pumps, fans, steam-raising plant, fuel oil pumping and storage installations, mechanical handling plant and general factory building maintenance, &c.

The operation and development of a preventive maintenance system and administration of services departments will be the successful applicant's main concern.

Replies in first instance, giving full details of experience, technical qualifications and salary required, should be addressed to Personnel Officer, Jackson Bros. (of Knottingley), Ltd., P.O. BOX No. 2, Knottingley, Yorks. E8345 A

MECHANICAL DETAIL DRAUGHTSMAN required, with general engineering experience. O.N.C. qualification an advantage but Junior keen to learn would be considered. Vacancy exists in plant drawing-office at St. Albans, Herts.—Please reply to BOX No. E2036, "The Engineer." A

MECHANICAL ENGINEER required for research on the plastic deformation of metals. Applicants should possess a Degree in Mechanical Engineering, or equivalent qualifications. This post offers excellent opportunities for a young man wishing to do basic engineering research, and at the same time gain experience of technical problems in a large and diverse engineering organisation.—For further details and application form, write to the Secretary, Tube Investments Research Laboratories, Hinxton Hall, Cambridge, quoting reference 141. E8309 A

MECHANICAL ENGINEER

with some electrical knowledge required to join group engaged on design and Site supervision of oil products pipeline and distribution depots in Iran. Knowledge of petroleum practice is essential. Applicants should be qualified, aged about 35, and have design experience of pumping and ancillary equipment. The successful applicant will be required to work in London office in the first instance.—Send fullest particulars to: Staff Office, Rendel, Palmer and Tritton, Consulting Engineers, 125, Victoria Street, London, S.W.1. E8330 A

METHODS ENGINEERS

required for modern factory some 60 miles from London.

Experience in (1) Plastic Moulding; or (2) Electro-Mechanical work essential. Successful applicants should be able to complete a methods study and development without supervision and be capable of recommending plant and equipment for new and current projects.

O.N.C. or equivalent plus Apprenticeship desirable.

Salary: £850–£900 per annum.

Write to Personnel Manager.—BOX No. E8344, "The Engineer." A

MONSANTO CHEMICALS, LIMITED, require a SERVICE ENGINEER to assist the company's services engineer to evaluate, specify and design plant for the generation of steam and the distribution of steam, water and compressed air, and to supervise design staff and contractors. The work carries a large degree of individual responsibility. Candidates, preferably aged about 30 years, should be qualified to at least N.C. standard and have a minimum of three years' experience in a position of responsibility on work as described above. The post is based on London, but will involve frequent travel to the company's factories at Ruabon, Newport and Fawley, with periods of 2–3 months at the factories when required. Salary commensurate with qualifications and experience. Non-contributory pension scheme.—Please send full particulars to Personnel Department (DL084), MONSANTO CHEMICALS, LIMITED, Monsanto House, 10/18, Victoria Street, London, S.W.1. E8365 A

O. W. ROSKILL, Industrial Consultants, 14, Great College Street, S.W.1, have an opening for a young Engineer or Chemist preferably with public school and university education for training in technical market research and other consulting work. An unusual combination of scientific outlook and ability to draft well is required, together with wide rather than highly specialised interest in technological matters. E2054 A

PILKINGTON BROTHERS LIMITED have vacancies for FURNACE DESIGN DRAUGHTSMEN. Experience in the design of glass furnaces is an advantage but is not essential. Salaries are assessed in accordance with age, qualifications and experience and will be reviewed annually. Contributory superannuation and widows' pension fund are in operation and there are excellent canteen, welfare and recreational facilities.—Apply, stating age, qualifications and experience, to the GROUP CHIEF ENGINEER, PILKINGTON BROTHERS LIMITED, ST. HELENS, LANCASHIRE. E8261 A

PIPE BENDING MACHINES—B. O. Morris, Coventry, are going into production of American Wallace pipe bending machines up to 18in. capacity. They seek an engineer to handle technical enquiries with the customer, the design office, the works and the Americans. The responsibilities of this position will be dependent upon the calibre of the man appointed.—Apply giving full details to The General Manager. E2056 A

PROGRAMME ENGINEER AND TECHNICAL CLERK REQUIRED on work involving and preparation of programmes for the installation of large-scale chemical and mechanical engineering work in the North of England. Applicants should have served in recognised engineering apprenticeships. —Write, giving details of age, experience to date and salary required to: British Oxygen Wimpey, Ltd., M. and E. Department, Spadeadam Research Establishment, Gilsland, near Carlisle E8295 A

RESIDENT ENGINEER, for boiler-house and general maintenance girls' senior, mixed primary and kindergarten boarding school at Purley, Surrey. Excellent accommodation, superannuation scheme, future prospects.—Apply Maintenance Manager, Russell School, Ballards, Addington, Croydon, stating salary required and giving experience, age, &c. E8360 A

SENIOR ENGINEERING APPOINTMENT

A WORKS ENGINEER is required by The Plessey Company Limited for its Ilford group of factories. This is a senior appointment with a wide sphere of responsibility covering provision of mechanical, electrical and other services, plant layouts and maintenance of buildings, which will offer excellent scope for a capable, experienced and energetic man. A good engineering background is essential. Experience in the field of plant maintenance will be an additional recommendation.

The post will be in the salary range £1800 to £2500 per annum and will entitle the holder to membership of the Company's pension scheme.

This is a real opportunity for a well-qualified engineer possessing drive and organising ability.

Applications, endorsed "Works Engineer" to the Executive Director (Personnel), The Plessey Company Limited, Ilford, Essex. E8322 A

SITE ENGINEERS required for supervision of Mechanical and Instrumentation work on a large-scale project in the North of England. Duties will include organisation and supervision of direct labour and Sub Contractors. Applicants should preferably be Corporate members of a Senior Institution and have appreciable experience in one or both of the above fields of work.—Write giving details of age, experience to date, and salary required to: British Oxygen Wimpey, Ltd., M. and E. Dept., Spadeadam Research Establishment, Gilsland, near Carlisle. E8296 A

STEWARTS AND LLOYDS, LIMITED

require an additional

REPRESENTATIVE

to handle sales of STEEL CASTINGS. Attractive conditions will be offered to a really capable and experienced man. Location—Midlands.—Apply to Manager, Personnel Services, Stewarts and Lloyds, Ltd., Clyde Tube Works, Coatbridge, Lanarkshire. E8346 A

STRUCTURAL ENGINEER wanted to fill vacancy as Chief Designer of expanding timber engineering division of large woodworking company, to take charge of large-scale development projects, laminated, stressed skin, and other forms of Timber Construction.—Apply with full details of age, training and experience to the Managing Director, Kingston (Architectural Craftsmen), Ltd., Clough Road, Hull. E2053 A

TECHNICAL ASSISTANT required for the Electrical Development Laboratory of the Lincoln Electric Company, Ltd.

Applicants should possess a degree or H.N.C. in electrical engineering and have experience in electrical machine design.

Contributory Staff Pension and non-contributory Life Assurance.

Applications stating age, experience and salary required should be addressed to Chief Electrical Engineer, Lincoln Electric Company, Ltd., Welwyn Garden City, Hertfordshire. E8349 A

TECHNICAL SALES REPRESENTATIVE required by large firm of Power Transmission Engineers, resident in Leicester, for attachment to Nottingham Branch. Applicants must have practical drawing-office and workshop experience. Sales experience not essential. Full details, age, qualifications and past experience.—BOX No. E8321, "The Engineer." A

THE BOWATER PAPER CORPORATION LIMITED HAVE A VACANCY FOR A CIVIL ENGINEERING DESIGN DRAUGHTSMAN. Applicants should have either passed Sections A and B Examination of the Institution of Civil Engineers or have obtained exemption. Practical experience should include reinforced concrete and structural steelwork design, layout of railways, roads, drains and sewers. Knowledge of surveying and setting out an advantage but not essential. Contributory Pension Scheme. Applications will be treated confidentially. —They should state details of age, education, training, experience and salary required and be sent to the Chief Engineer, THE BOWATER PAPER CORPORATION, LIMITED, Engineering Division, Northfleet, Kent. E8287 A

THE UNITED GLASS BOTTLE MANUFACTURERS, LTD., Anchor and Hope Lane, Charlton, S.E.7. An opening occurs for an apprentice-trained JIG AND TOOL DESIGNER, aged 25–30 years, minimum qualification O.N.C., who has at least five years' experience of batch production methods. The post, which is pensionable and carries an attractive salary, offers excellent prospects for a man of initiative capable of working with the minimum of supervision. —Please write to the Personnel Officer, stating age, qualifications, experience and salary required. E8364 A

WEST MIDDLESEX FIRM require immediately a competent ENGINEERING DRAUGHTSMAN, fully experienced in design of electro-mechanical devices.—BOX No. E136, "The Engineer." A

WORKS MANAGER required for important Engineering Works. Must have had good experience of aircraft detail manufacture and assembly. This is a responsible position with high salary and opportunity offered to experienced man. Works situated in Farnborough, Hants area.—Write in first instance giving details in strictest confidence to Managing Director, BOX No. E8338, "The Engineer." A

WORKS MANAGER required for progressive manufacturing engineers with modern works about 15 miles S.E. London.—Please write, stating age, experience to date and salary required, to The Secretary, BOX No. E2066, "The Engineer." A

PUBLICITY MANAGER

required by thriving Yorkshire Engineering Group who are expanding their field of activities both at Home and in Overseas Markets. Due to this it is essential that applicants are fully experienced men with ideas and a lively mind, supported by full experience in all branches of sales promotion and publicity. Must be capable administrators, holding similar position now. Engineering training desirable, age limits 30-45 years. Write for application form to:—

GENERAL SALES MANAGER,
CROFTS (ENGINEERS) LIMITED,
BRADFORD, 3. YORKSHIRE.

E8320 A

W. H. ALLEN SONS & COMPANY LTD. BEDFORD

require for their Production Engineering Department

WORK STUDY ENGINEERS

Experienced in the application of Work Study to machine or assembly shops.

DEVELOPMENT ENGINEERS

To investigate and improve manufacturing techniques.

DRAUGHTSMEN

For the design of Jigs, Tools, Fixtures and Tool Layouts.

These positions will interest men of sound education and practical experience, who can carry out on their own initiative, studies and investigations into problems affecting the small-batch production of Steam and Gas Turbines, Diesel Engines, Centrifugal Pumps and Electrical Machinery.

Please apply in writing, stating age, present salary and full details of education, training and experience to—

THE PERSONNEL MANAGER.

E8314 A

MSL have been retained to advise on the appointment of a

PRODUCTION EXECUTIVE

for a light engineering company, which is a subsidiary of a large American group, producing consumer products, and having interests throughout the world. The company in this country employs approximately 1,000 and is operating three factories with the main works in the London Area.

The appointment will carry responsibility to the Managing Director for the whole of the executive management of the factories and includes industrial engineering, plant design and development. Occasional visits to the associated companies in U.S.A., Canada, and on the Continent may be necessary.

Candidates must have a strong engineering background with a degree or other professional qualification, should have attained a position of responsibility preferably as production or works manager, and have experience of mass production and light engineering practice. A knowledge of modern control procedures and work study would be added recommendations.

Preferred age 40–45. Salary approximately £3,000 with good prospects of advancement.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.1188, to M. B. Berks.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1

E134 A

SITUATIONS VACANT

ENGLISH ELECTRIC, RUGBY

The Water Turbine Research Department invites applications from Engineers for the following vacancies :

TWO SENIOR MECHANICAL DRAUGHTSMEN. Must have experience of test plant arrangements and be capable of carrying out their own design work.

TWO SENIOR TEST ENGINEERS, of H.N.C. standard, capable of carrying out comprehensive model tests and making evaluations of results obtained.

A MATHEMATICIAN of degree standard for programming work and general mathematical investigations. Would suit a recently qualified Graduate.

Previous experience of water turbine work is not essential if Hydraulics has been taken as a subject, this would be an advantage. The work is interesting and varied and offers good openings to men wishing to enter the field of Hydraulic Engineering.

Please write giving full details to Dept. C.P.S., 336/7, The Strand, W.C.2, quoting Reference E.1108D.

E8331 A

THE NUCLEAR POWER PLANT COMPANY LIMITED

requires

ENGINEERS

to commission Nuclear Power Stations.

Applicants should have had considerable experience in operation of Conventional Power Stations.

The successful candidates will receive extensive "nuclear" training.

The Company operates a contributory pension scheme and assistance with house purchase is given to married men.

Applications, giving age, qualifications and experience, should be sent to :—

The Secretary,
The Nuclear Power Plant Co. Ltd.,
Booths Hall,
Knutsford, Cheshire.
Quoting reference TE/CMS/55.

E8318 A

SCOTT & WILSON, KIRKPATRICK & PARTNERS

Consulting Civil and Structural Engineers
47, VICTORIA STREET, LONDON, S.W.1,

invite applications for the appointments of

RESIDENT ENGINEER

and

CLERK OF WORKS

to be engaged upon the supervision of the construction of Sea Defence Works, comprised of about 4600ft. of reinforced concrete seawall, together with the construction of about 23 timber groynes and other ancillary works at Prestatyn, North Wales.

The salaries for these appointments are :
(a) Resident Engineer—£1200 to £1400 per annum, depending upon experience.
(b) Clerk of Works — £900 per annum.

Applicants for the senior appointment should be Corporate Members of the Institution of Civil Engineers and have had considerable experience in sea defence works. Applicants for the Clerk of Works appointment must have been previously employed in a similar capacity on such works.

Both appointments will be, subject to satisfactory service, for the duration of the works, which is estimated to be in the region of 18 months.

Applications should be made in writing to the above address, stating full particulars of age, qualifications and experience, together with the names of two referees.

E8317 A

ENGLISH ELECTRIC RUGBY

Vacancies exist in the Steam Turbine Division for the following Engineers :

(a) AERODYNAMICIST with experience of high-speed flow for work on aerodynamic aspects of turbine design, and other associated projects.

(b) Senior STRESS ENGINEER to set up a stress section for fundamental investigations of turbine design. This is a new section and offers considerable scope to an Engineer age 30–40 with considerable experience in this class of work.

(c) ASSISTANT ENGINEER, preferably of honours degree standard, age 28–40, with a background of heavy mechanical engineering design or thermodynamic calculations.

The foregoing vacancies offer good opportunities in a well-established highly successful department which is constantly investigating new developments in the field of steam power engineering. Interested applicants should write giving full details of previous experience at the earliest opportunity. Details of housing assistance, salaries, etc., will be given at interview.—Please write to Dept. C.P.S., Marconi House, 336/7, The Strand, W.C.2, quoting reference E1107G.

E8332 A

SITUATIONS VACANT

BICC

British Insulated Callender's Construction Co., Ltd., carrying out important Railway Electrification contracts in connection with the Transport Commission's railway modernisation programme, require additional Design Staff at their Traction Department Headquarters, Kirkby, Nr. Liverpool, namely :

STRUCTURAL ENGINEERS
DESIGNERS
DRAUGHTSMEN

The work is varied and interesting, involving the design of foundations and structures carrying overhead wiring. Appointments are intended for the Company's permanent staff ; prospects are good and salary will be generously assessed according to age, qualifications and experience.

Applications should be addressed to :
The Works Personnel Officer,
Ref. C.355,
B.I.C.C., Ltd.,
Prescot, Lancs.

E138 A

DRAUGHTSMEN

Due to expansion in their
MINING DIVISION,
SIMON-CARVES LTD.,
have a limited number of vacancies for :

MECHANICAL DRAUGHTSMEN

for the design of skip and cage winding equipment and general colliery surface plant. Applicants must have D.O. experience in heavy mechanical engineering, preferably in connection with collieries, but experience in other fields, e.g. locomotives, armaments, heavy mechanical handling plant, will be considered. These positions are permanent and pensionable. Salaries within the range £750—£1000 p.a. depending on previous training and experience.—Send brief relevant details to Staff and Training Division, SIMON-CARVES, LTD., Cheadle Heath, Stockport, Cheshire, quoting Ref. DJ.47.

E8319 A

THE BAHRAIN PETROLEUM COMPANY LIMITED

require a

MAINTENANCE ENGINEER

This post is open to recent graduates in Mechanical Engineering, under 28 years of age, who are interested in all phases of planned maintenance of heavy plant and who have preferably some experience on pressure vessel, heat exchanger and pump repair. It is intended that the selected candidate should train in Bahrain with a view to advancement to at least Area Engineer in the large and modern refinery there.

A good salary can be offered dependent on qualification, in addition to which air-conditioned accommodation is provided with an adequate living allowance, medical attention, kit allowance, and paid local and home leaves with participation in pension and provident fund plans.

Apply in writing (quoting MTC), with full particulars, to :

CALTEX SERVICES LIMITED,
CALTEX HOUSE,
KNIGHTSBRIDGE GREEN,
LONDON, S.W.1.

E8329 A

OIL BURNER DESIGN AND DEVELOPMENT ENGINEER

is required by a leading Engineering Company for work on the firing systems for a specialised range of industrial furnaces. Applicants should have design and practical experience of both low and medium air pressure oil burners and automatic control equipment. Experience of industrial gas burners would be a useful additional qualification.

Candidates should be of at least H.N.C. standard, between the ages of 28 and 40, and have the qualities of a potential leader. Some travelling will be involved. The salary will depend on qualifications and experience but will be in the range of £850–£1200 per annum.

The Company provides first-class conditions of employment, including contributory pension, life assurance and profit sharing schemes, and will usually pay any removal expenses incurred. Applications, which will be treated in strict confidence, should include full details of qualifications and career to date and be addressed to BOX No. B.1915, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4.

E8358 A

SITUATIONS WANTED

ENGINEER (29), 2nd Class M.O.T. (Motor) Certificate, G.I.Mar.E. Steam experience. Offers : initiative, versatility and effort. All shore situations, home or abroad, considered.—BOX No. E2051, "The Engineer." B

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A MECHANICAL ENGINEER, B.Sc.Tech., aged 37, seeks responsible job in south of England or abroad. Previous experience in Overhaul of Jet Engines and Earth-moving Equipment.—BOX No. E2059, "The Engineer." B

ENGINEER (31), married, with considerable diesel engine experience, seeks position abroad, responsible for the running and maintenance of diesel power station.—BOX No. E2060, "The Engineer." B

DIESEL ENGINEER, Management, Service, Sales, desires appointment any country. Experience : Scotland, Malaya, Borneo, Singapore. Scot, age 30. —Address, Freeman, "Uniteers," P.O. Box 41, Singapore. E2065 B

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CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

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All Plant is modern, being installed within the last few years and housed in a complete new Works.

All enquiries will be answered and dealt with promptly. Further details can be supplied if necessary and personal visits arranged if desired.

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E2048 MW

Classified Advts. continued on page 108

PATENTS

NOTICE IS HEREBY GIVEN that LEON NUSSBAUM seeks leave to amend the Complete Specification of Letters Patent No. 774,817 for an invention entitled "IMPROVEMENTS IN OR RELATING TO HARD METAL CARBIDE PRODUCTS AND THEIR MANUFACTURE."

Particulars of the proposed amendments were set forth in the Official Journal (Patents), No. 3623, dated 23rd July, 1958.

Any person may give Notice of Opposition to the amendment by leaving Patents Form No. 36 at the Patent Office, 25, Southampton Buildings, London, W.C.2, on or before the 23rd August, 1958.

GORDON GRANT,
Comptroller-General.

E8359 H

FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1 (Phone, SLOane 5259). E105 K

HIRE A £1500 CAMERA FOR ONLY £5. All other types of photographic equipment available.—B. Bennett and Sons, Ltd., 25/27, Oxford Street, London, W.1 (Telephone, GERard 9953). Catalogue on request. E128 K

MACHINERY Etc. WANTED

WANTED, Machines of all Types.
CASH PAID.
Norman E. Potts (B'ham), Ltd., 130, Mossley Road, Birmingham, 12. VIC. 1278, 1279, 1270, 0856.
E104 F

WANTED, Second-hand Dynamic Balancing Machine, weight capacity 7000 lb, approximately, maximum swing 60in., length between bearings 96in., complete with electrical equipment.—Full details to BOX No. E8305, "The Engineer." F

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600

METAL ROLLING MILLS

Motor-driven, 4-High Rolling Mill, by W. H. A. ROBERTSON and CO., LTD., rolls 57in. by 14in. by 28in., double helical gear drive from 250 h.p. D.C. motor, suitable 440-volt supply, speed 77 to 154ft. per minute.

Motor-driven 2-High Rolling Mill, by SIR JAMES PARMER NORTON, new 1954, rolls 30in. by 22in. dia., reversing type with run in and out roller tables, along with coiler and guillotine shears, direct driven by 275 h.p. D.C. motor, suitable 440 volts, speed 49 to 73ft. per minute.

Motor-driven, 2-High Mill, by Taylor and Farley, rolls 36in. by 24in. dia., direct driven by 250 h.p. D.C. motor, suitable 440 volts, speed 27 to 55ft. per minute.

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Tel.: Pudsey 2241. E204 G

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10 Euclid 22-ton Rear Dump Trucks, fitted Rolls Royce Diesels. Not yet two years old. Very good order. Cost £12,500 each. Accept £60,000 the lot, or sell two lots.

2 Cat. D.7. type 3T. Delivered new December 1951 and June 1952. Both fitted Birtley hydraulic Angledozers and P.C.U. Very good order. Price £8250 or separate.

Birtley 70 Scraper and Onions EK9. Tyres over 70 per cent original tread. Price £1800 the two.

D.8. 14A, with Birtley Angledozer. Just two years old and fitted new track chains. Used single shaft only. Cost £14,000. Price £9000.

Ruston 10, 19, 22, 24 and 33-RB Excavators, any equipment.

Coles diesel/electric orry mounted crane, fitted Thornycroft diesel and Perkins P6 for electrics. New 1955, very little used. Tyres as new. Cost £7800. Price £5400.

All machines will be checked over, cleaned, painted and delivered F.O.B.

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E8353 G

HYDRAULIC UNIVERSAL GRINDER

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F. J. EDWARDS, LTD.,
359–361, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681 and 3771.

E8308 G

LORAIN CRAWLER 79 at £2400 O.N.O., comprising 45–60ft. jib, 1½ yd. bucket, fairleads, and bucket boom, Caterpillar engine, in sound order. JONES TATE 5-ton Petrol-Electric on solids, yard use only. Superior condition. Bargain £950.—Smiths, 38–40, Stoke Green, Coventry (52462).
E2045 G

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30½in. HARVEY Long Bed S.S. and S.C. Lathe, motor drive, two saddles with rapid power traverse, swing over bed 61in., admits between centres 61ft.

19in. CRAVEN S.S. and S.C. Lathe, motor drive, vee bed, swing over bed 38in., swing over saddles 26in., admits between centres 28ft.

18in. LE BLOND Heavy Duty Geared Head Engine Lathe, size 32in., admits between centres 28ft.

16in. FAIRBAIRN LAWSON Heavy Duty S.S. and S.C. Lathe, motor drive, swing over saddle 23in., admits between centres 15ft.

14½in. CRAVEN S.S. and S.C. Lathe, motor drive, 2 saddles, swing over bed 29in., swing over carriages 20in., admits between centres 28ft.

13½in. MONARCH Geared Head S.S. and S.C. Lathe, type CM, 24in., motor drive, swing over carriage 14in., between centres 24ft.

13½in. LODGE & SHIPLEY S.S. and S.C. Lathe, vee bed, Norton gearbox, motor drive, swing over bed 27½in., swing over saddle 19in., admits between centres 14ft.

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E212 G

VALES PLANT REGISTER LIMITED

OFFER FOR IMMEDIATE SALE

One Jones KL22 2-ton Diesel Mobile Crane, Ruston engine, 24ft. lattice jib, on pneumatics. New 1954. Very good condition. £1500.

One Neals NM 2-ton Diesel Mobile Crane, Ruston engine. New 1950. On crawlers, 25ft. jib. In good condition. £700.

One Jones "Super 40" 3-ton Mobile Crane, 24ft. jib, on pneumatics, Ruston engine. Good condition. £925.

ONE Neals QM 4/6-ton Diesel Mobile Crane, with 45ft. jib, on pneumatics, Ruston engine. New 1953. In good condition.

One 6-ton Coles Model S88 Diesel-Electric Mobile Crane. New 1951. 21ft. 9in. cantilever jib, on solid rubber tyres. In good mechanical condition. £2500.

ONE 5-ton Butters Electric Travelling Derrick Crane, with 90ft. jib. New 1948. With bogies, track and ballast blocks. In very good condition.

One 7-ton Butters 2-motor Electric Derrick Crane, with 120ft. jib. In very good condition.

One 5-ton Grafton Diesel Rail Crane. New 1942. Perkins P6 engine, 38ft. jib, 4ft. 8½in. gauge. Reconditioned.

One 7-ton Anderson Grice 2-motor type Electric Derrick Crane, 120ft. jib. New 1951. With cabin. In very good condition.

One 7-ton Butters Steam Derrick Crane, 100ft. jib, double-drum type. Unused.

One 10-ton Henderson Steam Derrick Crane, 120ft. jib. First used 1954. In very good condition.

One 12½-ton Coles Fully Mobile Crane, with 45/80ft. jib. New 1950. £5500.

Further details, 14, Lower Grosvenor Place, London, S.W.1. Telephone : VICtoria 7531, 3501, 8080, 9886 (15 lines). E107 G

Oldfield & Schofield 33in. swing, Heavy Duty **BORING AND FACING LATHE.** Swing over bed 33in. Hexagon turret. A.G.H. Spindle bore 4½in. Screw-cutting from Q.C.G. Built 1954. 15 H.P. motor, 400/3/50.—H. BELL (MACHINE TOOLS), LTD., WALTER STREET, LEEDS, 4.
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TWO Excellent little used Steel enclosed CHAIN AND BUCKET COAL ELEVATORS, approx. 83ft. centres, with buckets 20in. by 9in. by 8in. at 12in. pitch. Drive by 15 h.p. tot. encl. 400/3/50, motor with 1420/235 Geared Unit.

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E200 G

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.

40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.

40-ton Adamson, standard cab control, 42ft 3in. span 400/3/50.

20-ton Vaughan, standard cab control, 42ft. 3in. span, 6-ton auxiliary ; 400/3/50. EIGHT AVAILABLE.

10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.

Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices about one-third of New.

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QUICKWORK No. 321 Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50. Capacity : 14 S.W.G. mild steel. Depth of shear throat 30in. Cuts circles from 6in. to 60in. diameter. Weight approximately 18 cwt.

B.E.N. Model TS9 2-Stage Automatic Air Compressor Unit. Comprising : 2-stage vee type air cooled compressor, arranged motor drive for 400/440/3/50. Motor and compressor mounted on horizontal air receiver. Displacement 9 cu. ft. per minute. Working pressure 200 lb. per square inch.

BESCO High-Speed Open End Guillotine Shearing Machine. Undercrank type, arranged motor drive for 400/440/3/50. Fitted with automatic sheet hold-down and complete with front, back and side gauges. Capacity : mild steel 48½in. by 14 S.W.G.

TAYLOR & CHALLEN No. 3 G.D.P. Geared, Double Sided, Double Action, Cam Action Drawing Press, arranged motor drive for 400/440/3/50. Punch stroke approximately 7in. Blankholder stroke approximately 3½in. Tee-slotted bed 18in. by 15½in. Between uprights 20½in. Weight approximately 51 cwt.

BLISS No. 20 Inclinable Power Press with adjustable stroke, arranged motor drive for 400/3/50. Fitted with automatic press guard and guard over drive. Pressure exerted approximately 20 tons. Stroke adjustable from ½in. to 2½in. Size of bed 21½in. by 13½in. Weight approximately 22 cwt.

INCANDESCENT Forced Draft Bar Heating Furnace, double-ended, gas fitted. Heating chamber 36in. wide by 24in. deep by 9in. high. Total length through furnace 32in. working. Temperature range 900 deg. to 1350 deg. C. ; 1200 deg. C. can be reached in about 1½ hours after starting from cold.

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MOBILE CRANES

JONES KL.66 Mobile Crane, lifting capacity 6 tons at 9ft. radius, powered by a Perkins P.4. diesel engine, mounted on pneumatic-tyred chassis with restrictor type wheels, 4-wheel differential drive, power assisted steering, 25ft. channel jib, complete with 38in. electro magnet equipment.

JONES KL.66 Mobile Crane, powered by a Perkins P.4. diesel engine, mounted on pneumatic-tyred chassis with restrictor type wheels, 4-wheel differential drive, 30ft. lattice jib, fitted with second drum for operating 21/17 cubic ft. capacity double rope grab.

JONES KL.44 Mobile Crane, lifting capacity 4 tons at 8ft. radius, powered by a Ruston 2.VSH diesel engine, mounted on pneumatic-tyred chassis with restrictor type wheels, 24ft. straight channel jib, complete with 21/17 cubic ft. capacity single-chain ring-discharge grab.

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Unused 4000-ton HYDRAULIC HEAVY PLATE FORMING and BENDING PRESS, table 18ft. by 10ft., weight 380 tons.

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E8278 G

FOR DISPOSAL at Thames Board Mills, Ltd., Mersey Works, Warrington, Lancs., one Armstrong Whitworth Diesel Locomotive, approximately 20 years old, with stock of spares.

Requires some attention to put into good working order.

May be viewed by appointment—telephone Warrington 33501.

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E113 G

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Two New 1050kVA., 440/3/50, 4-wire Diesel-engine driven Alternator Sets by MIRRLEES/E.C.C., speed 428 r.p.m., with control gear and standard ancillaries, also starting equipment.

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3-ton Taylor Jumbo Hydraulic Crane, diesel-driven.
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5-ton Coles diesel-driven self-propelled Mobile Crane on pneumatics.
5-ton Morris Versatile diesel/electric Mobile Crane on solid rubber tyres.
5-ton Smith Steam Loco. Crane 4ft. 8½in. gauge, 35ft. jib, new 1949.
6-ton Rapier Super petrol/electric Mobile Crane on solid rubber tyres.
6-ton Rapier Standard petrol/electric Mobile Crane on solid rubber tyres.
Fordson Major diesel Tractor, complete with Hornd-raulic shovel equipment.
¾ cu. yd. Rapier 410 diesel-driven Excavator with 4-purpose or dragline equipment.
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E7976 G

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AIR COMPRESSORS.—Broomwade 400, 300, 200 and 130 cu. ft.; all motorised ; Reavell Rotary Blowers, 2000 c.f.m., 3–2 p.s.i.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.–70ft. extendable jib ; 6-ton and 4-ton Coles Diesel-Electric ; 3-ton Jones Super 40 (3) ; Neals 2-ton Diesel, 20ft. jibs (2) ; Derrick, 5-ton Butters Electric travelling type, 90ft. jib ; 5-ton Wilson Electric, 70ft. jib ; Steam Loco, 18-ton Brownhoist, 50ft. jib ; 10-ton Coles, 40ft. jib ; 8-ton Wilson, 35ft. jib ; 5-ton Smith, 50ft. jib ; 5-ton Cowans Sheldon, 50ft. jib ; 5-ton Grafton, 38ft. jib ; E.O.T., 40-ton Adamson, 42ft. span ; 20-ton Vaughan, 42ft. span (8) ; Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris ; 5-ton Henderson, 24ft. 7½in. span, 1946 ; 5-ton King, 29ft. 3in. span ; 2-ton Morris, 18ft. span, 2-ton Smith, 34ft. span.
LOCOS.—Fowler Diesel, 150 h.p. (2) ; Ruston Diesel, 80/88 h.p., new 1942 ; Hunslet 0–6–0, 18in. by 26in., new 1944 ; Bagnall 14in. by 22in., two oil fired, one coal ; Peckett Steam, 7in. by 12in., 1941 ; Also 3 miles track, 24in. gauge Bogies, Turnouts, &c.
STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft., 3in. black new ; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 2800ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.
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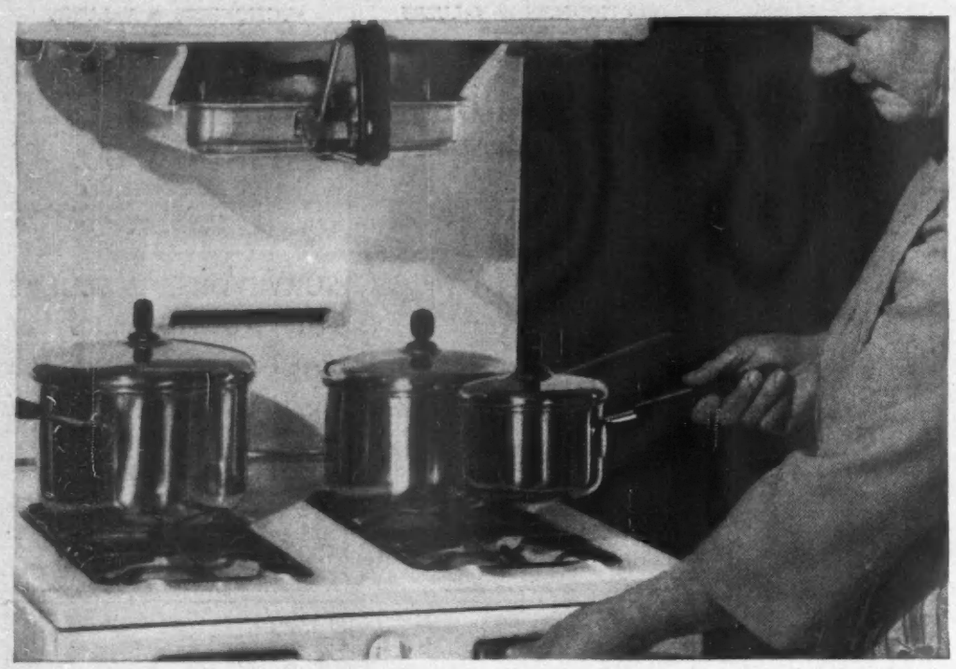

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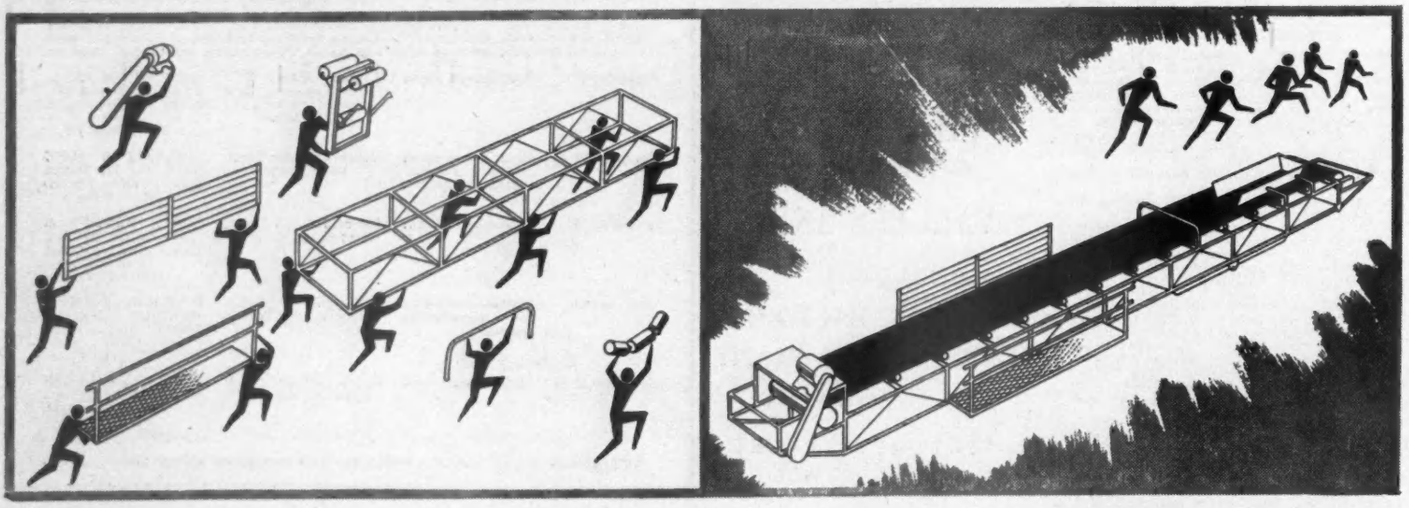

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Airnesco Products, Ltd.	88
Alldays & Onions, Ltd.	75
Allen, E., & Co., Ltd.	55
Allen, W. H., Sons & Co., Ltd.	60
Armstrong Patents Co., Ltd.	7
Armstrong Stevens & Son, Ltd.	72
Atlas Preservative Co., Ltd.	46
Automotive Products Co., Ltd.	31
BX Plastics, Ltd.	39
Bache, G., & Son	18
Barlow-Whitney, Ltd.	4
Bennett & Sayer, Ltd.	66
Bennett (Hyde), Ltd.	81
Bird, W. H., & Sons, Ltd.	111
Birfield Industries, Ltd.	44
Birmetals, Ltd.	28
Birmingham & Blackburn Construction Co., Ltd.	70
Blackheath Stamping Co., Ltd.	71
Booth, J., & Bros.	37
Boulton Paul Aircraft, Ltd.	19
Brett's Patent Lifter Co., Ltd.	58
Bridges, G. F., Ltd.	25
British Aluminium Co., Ltd.	112
British Ermeto Corp., Ltd.	38
British Paints, Ltd.	102
British Thomson-Houston Co., Ltd.	3
British Timken, Ltd	Cover i
Broom & Wade, Ltd.	94
Brown, D. (Brownall), Ltd.	52
Brown, E. G., & Co., Ltd.	51
Brownlie & Murray, Ltd.	98
Bruce Peebles & Co., Ltd.	10
Burndept, Ltd.	97
Burnley Aircraft Products, Ltd.	32
Burrell, E. C., & Sons, Ltd.	61
Butcher, H., & Co.	109
Caird, F., Ltd.	57
Cambrian Wagon & Engineering Co., Ltd.	7
Carlisle, C. G. & Co., Ltd.	63
Chance Bros., Ltd.	85
Chatwin, T., & Co.	99
Chesterfield Tube Co., Ltd.	2
Clarke, Chapman & Co., Ltd.	8
Clyde Crane & Booth, Ltd.	37
Clyde Crane & Engineering Co.	37
Clyde Rubber Works, Ltd.	97
Cockburns, Ltd.	35
Cooper & Co. (B'ham.), Ltd.	Cover ii
Crofts (Engineers), Ltd.	42–43
Cross Manufacturing Co. (1938), Ltd.	36
Crowthorn Engineering Co., Ltd.	83
Cuxson, Gerrard & Co., Ltd.	57
Danks of Netherton, Ltd.	22
Distington Engineering Co., Ltd.	67
Donovan Electrical Co., Ltd.	26
Doxford, W., & Sons (Engineers), Ltd.	82
Drum Engineering Co., Ltd.	70
Drummond-Asquith (Sales), Ltd.	50
Dunlop Rubber Co., Ltd.	79
Eagle & Wrights (Gauges), Ltd.	66
Electrical Energy	105
Elliston, Evans & Jackson, Ltd.	100
Ellison, G., Ltd.	49
English Electric Co., Ltd.	54
Fairitt Engineering Co., Ltd.	84
Farmer, L., & Sons	109
Firth Brown Tools, Ltd.	96
Foord, J., & Co.	109
Ford Motor Co., Ltd.	70
Fowler, J., & Co. (Leeds), Ltd.	34
Fuller, Horsey, Sons & Cassell	109
Geipel, W., Ltd.	108
General Electric Co., Ltd.	22–81
Glenfield & Kennedy, Ltd.	30
Goodwin, R., & Sons (Engineers), Ltd.	85
Grafton Cranes, Ltd.	76
Greenwood's Standard Gear Cutting Co., Ltd.	84
Harlow, R., & Son, Ltd.	25
Harvey, G. A., & Co. (London), Ltd.	53
Heap, J., & Co., Ltd.	58
Hick Hargreaves & Co., Ltd.	45
Horseley Group	92
Ince Forge Co.	98
International Meehanite Metal Co., Ltd.	68
Ironsides Lubricants, Ltd.	98
Kay, S., Rubber Co., Ltd.	36
Keelavite Rotary Pumps and Motors, Ltd.	Cover iv
Kempe's Engineers Year-Book	51–105
Kirk & Co. (Tubes), Ltd.	78
Knight, Frank & Rutley	109
Krupp, Fried.	47
Lafarge Aluminous Cement Co., Ltd.	27
Langley Alloys, Ltd.	52
Ledward & Beckett, Ltd.	57
Leeds Engineering & Hydraulic Co., Ltd.	76
Lilleshall Co., Ltd.	91
Linread, Ltd.	13
Loveridge, Ltd.	35
Mabey & Johnson, Ltd.	99
Machinery Installations, Ltd.	61
MacLellan, P. & W., Ltd.	88
Madan, C. S., & Co., Ltd.	102
Mallinson & Eckersley, Ltd.	111
McNeil, C., Ltd.	66
Marbaix, Gaston E., Ltd.	98
Matthew Hall Group of Companies	11
Matthews & Yates, Ltd.	23
Mavitta Drafting Machines, Ltd.	91
Maxim Conveyors (England), Ltd.	110
Maxseal Valves, Ltd.	87
Metal Constructions, Ltd.	Cover ii
Metal Structures, Ltd.	21
Metropolitan-Cammell Carriage & Wagon Co., Ltd.	26
Metropolitan - Vickers Electrical Co., Ltd.	33–89
Midgley & Sutcliffe, Ltd.	16
Mills, G. (Engineers), Ltd.	85
Mirrlees (Engineers), Ltd.	36
Mobil Oil Co., Ltd.	40
Modern Conveyors, Ltd.	57
Mond Nickel Co., Ltd	110
Mono Pumps, Ltd.	100
Morgan Crucible Co., Ltd.	80
Mould, A. H., & Sons, Ltd.	61
National Boiler & General Insurance Co., Ltd.	66
Negretti & Zambra	86
Neill, J., & Co. (Sheffield), Ltd.	51
Newall, A. P., & Co., Ltd.	71
Newton Sales Co., Ltd.	99
Newton Victor, Ltd.	33
Niagara Screens (Great Britain), Ltd.	87
Non-Ferrous Die Casting Co., Ltd.	83
Norton, Sir J. Farmer, & Co., Ltd.	5
Oscard, J., & Co.	75
P.R. Motors, Ltd.	83
Parker, F., Ltd.	38
Parsons, C. A., & Co., Ltd.	93
Peckett & Sons, Ltd.	74
Peebles, Bruce, & Co., Ltd.	10
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Phillips, B. L. & N., Ltd.	101
Pinchin, Johnson & Co.	15
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Robertson & Ferguson, Ltd.	5
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Robson, G., & Co. (Conveyors), Ltd.	36
Rose, Downs & Thompson, Ltd.	25
Ross, D., & Partners, Ltd.	84
Rubber-By-Products (Warwickshire), Ltd.	84
Russell, G., & Co., Ltd.	111
Sadi Engineering Co., Ltd.	32
St. Georges Engineers, Ltd.	85
Salford Electrical Instruments, Ltd.	21
Saunders Valve Co., Ltd.	77
Schieldrop & Co., Ltd.	100
Shaw & McInnes, Ltd.	83
Shawe Metal Spinning Works	98
Sheepbridge Alloy Castings, Ltd.	18
Siebe, Gorman & Co., Ltd.	62
Skefko Ball Bearing Co., Ltd.	56
Small, W. H., Ltd.	18
Smedley Bros., Ltd.	58
Smith, J. (Keighley), Ltd.	73
Smith, S., & Sons (England), Ltd.	29
South Durham Steel and Iron Co., Ltd.	65
Standard Piston Ring & Engineering Co., Ltd.	72
Steels Engineering Products, Ltd.	12
Steelway, Ltd.	16
Sykes, H., Ltd.	17
T.I. Nuclear Engineering, Ltd.	23
Taylor & Hubbard, Ltd.	75
Teale, J. W., Ltd.	98
Technological Institute of Gt. Britain	105
Thompson, J., Group	48
Towler Bros. (Patents), Ltd.	Cover iii
Unbrako Socket Screw Co., Ltd.	66
Unicone Co., Ltd.	15
Visco Engineering Co., Ltd.	2
Vokes, Ltd.	64
Walker Bros., Ltd.	97
Ward, T. W., Ltd.	24–58–108
Wellman Smith Owen Engineering Corporation, Ltd.	69
Wells, A. C., & Co., Ltd.	21
Weston, C., & Co., Ltd.	41
Westool, Ltd.	74
Westwood, J., & Co., Ltd.	91
Wheatley Kirk, Price and Co.	109
Wiggins, F., & Sons	111
Wilkinson Rubber Linatex, Ltd.	78
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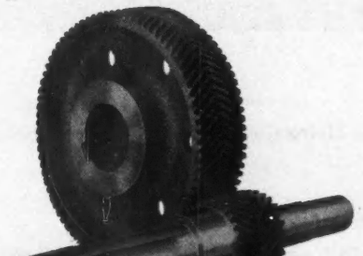

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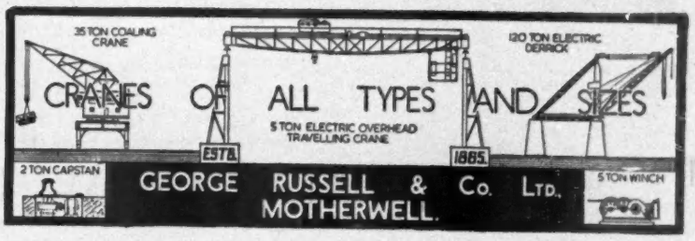

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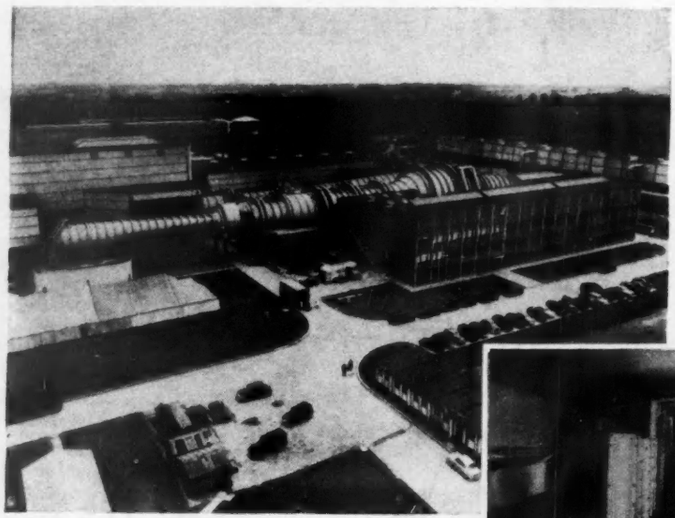

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